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6 (i) R. B. Walton and H. B Woodruff, *F. Clin. Inst*, **82**, 924, 1949.
(ii) W. C. Boyd, Fundamentals of Immunology, 1947, p. 123. (Interscience Publishers Inc., New York).

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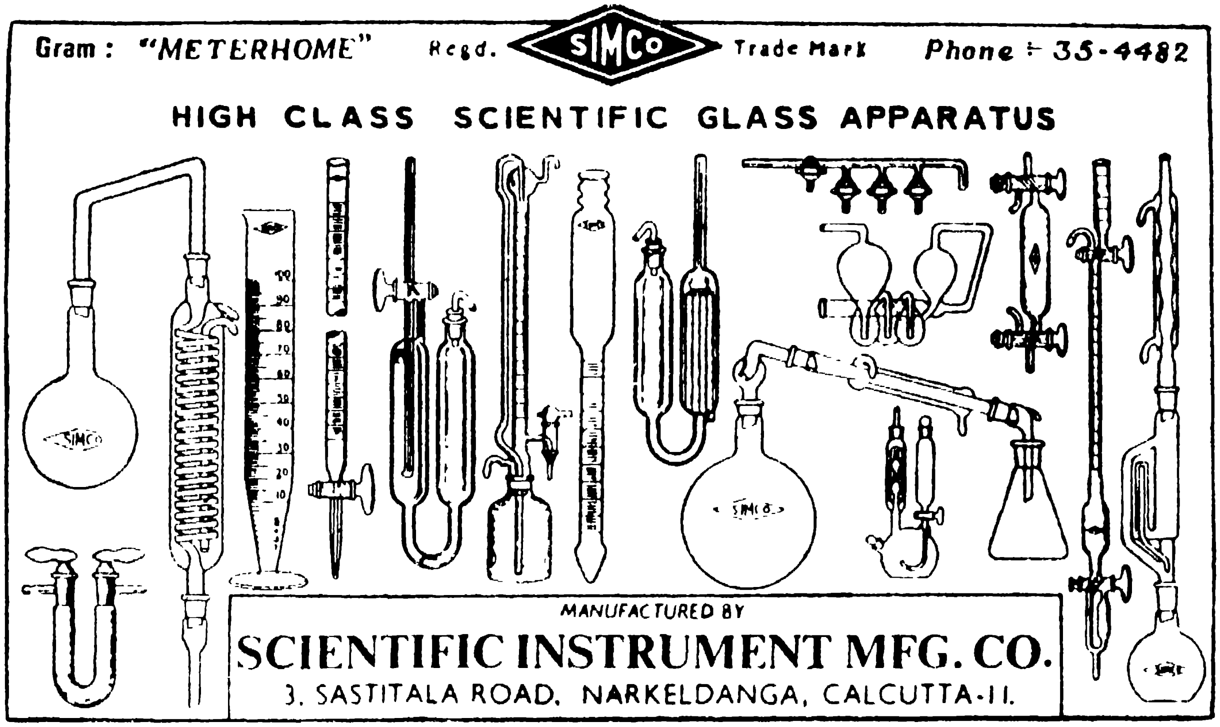
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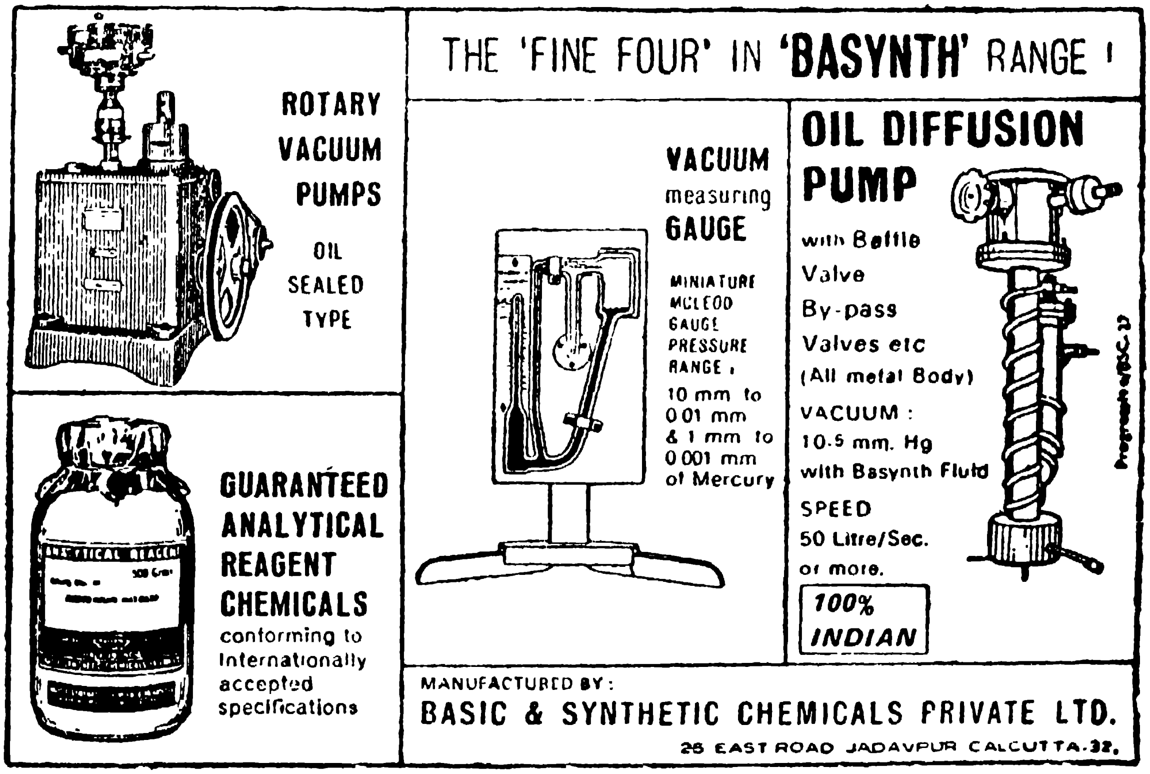
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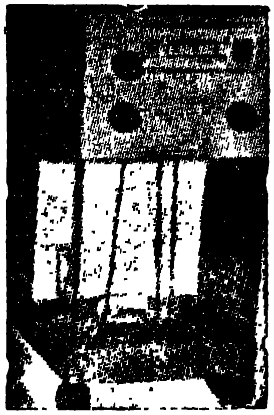

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FRONTIERS OF SCIENCE AND TECHNOLOGY : THE INDIAN CONTEXT*

C. N. R. RAO**

THE topic is obviously important since we in India have decided to take the path of science and technology to ensure development of our society. We have no choice other than to be abreast with the most up-to-date developments in science and technology. We would have to compete at least in some of the areas with the rest of the world, and at the same time identify those areas of special concern to us where. through the application of science and technology, we can make a signal contribution in solving the pressing problems, related to the needs of the common man There is a third aspect of science and technology, where by virtue of certain geographical and other natural advantages, we would have to be world leaders ; beneficiation of solar energy may represent one such area.

Some may feel that it is not necessary to worry about the frontiers of science and technology, if our main concern is to alleviate proverty and human suffering. But we should not forget that to take care of the health of the poorest amongst us, we require science and technology ; to grow the food we require, we have to apply advanced science and technology. In order to find substitutes to our depleting natural resources and also to discover newer types of materials required for construction, electronics and for alternate sources of energy, we require advanced science and technology. It is for this reason that I believe that the frontiers of science and technology are of direct relevance to even the poorest country in the world. Particularly in a large country such as ours with a large population, we cannot possibly afford to depend on advances in science and technology obtained elsewhere and depend on other countries to provide the help we need.

Smaller countries would have small requirements ; they would need small quantities of food, fertilizers, medicines and most materials. We, on the other hand, require large quantities of anything that we can think of. We can only compare ourselves to the larger countries of the world in terms of our needs. This places on us a special responsibility not only to our society but to science and technology itself. We have to be leaders in science and technology to show that even poor countries of the world have much to contribute to society in the modern world and that science is not the prerogative of only the advanced and rich nations.

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*Excerpts of Address given by Prof. C. N. R. Rao as General President of 75th Indian Science Congress 1988.

**Indian Institute of Science, Bangalore.

Applied Versus Basic Research

It would be appropriate here to comment on the unnecessary dichotomy between applied and basic research that seems to plague our scientific efforts. Many people have felt that we need to do mainly or only applied research in a developing country such as ours I feel that this would be a poor way of doing science. I suggest that for the sake of science and technology in the country, we stop using the terms "applied" and "basic" research from now on. Basic research is driven mainly by the aspirations of scientists who make discoveries ; we could classify such research as discovery-driven research. There is the other kind of research, which may call society-driven (or market-driven) research. Scientific breakthroughs come rarely in discovery-driven research, but once made, they lead to major innovations and quantum leaps in science and technology. Such research requires time, patience, perseverance and dedication, and results cannot always be predicted. The discovery of the electron is an old example of discovery-driven research. Lasers constitute a modern example of discovery-driven research. When the laser was first discovered, it was not expected to have great applications. Today, lasers are required in engineering, medicine and many other spheres.

Whether a country is rich or poor, lasers will be used in some way or the other. Once a major discovery is made, a considerable amount of applied research will have to be carried out to see that the result of the discovery becomes useful or leads to innovation.

Let us look at what I called market-driven or society-driven research. Here, the research is motivated by societal forces demanding certain products or innovations. For example, there may be a need for a specific type of high strength polymer or a special variety of hard material. Although the objectives are clearly spelled out, in order to make such a material one may have to carry out considerable fundamental research. Immaterial of whether research is discovery-driven or society-driven, it may require fundamental as well as applied work in order to give rise to innovations. It is only in limited instances that ready solutions to short-range problems are found by simply applying known principles or techniques. Applied and basic research are equally important components, and both required a high quality of mind. We cannot possibly have second-rate scientists for developmental work and first-rate scientists for fundamental work.

The Global Scenario

Today, science and technology are advancing at an extremely rapid pace. The pace is so fast indeed that we have to keep galloping just to remain stationary. The explosion of scientific knowledge is superexponential and to fully keep up with the literature is almost impossible. Under these conditions, can we compete meaningfully in the frontiers of science and technology from India ? Of course, there are many impediments due to the poor infrastructure, shortage of talented workers, oppressive bureaucratic practices and inadequate information systems. In spite of such limitations, we still have a chance, if we become more optimistic and approach problems with dedication. This does not mean that it is not going to be difficult to beat the pressures to buy foreign technology indiscriminately or to get world recognition in basic science. Even if one produces laboratory results of a quality comparable to the best, the world may not rightaway give the due recognition. The main point is that we just cannot afford to give up.

The view of India in the world has changed in the last few years. Most countries in the world (including the advanced ones) consider India to be a fairly advanced country in science and technology. This is not altogether a happy situation. This means that we can no longer behave like a "poor" country in science and technology. We have to really become good and competitive, at least to live up to this reputation. Otherwise, I am afraid that the reputation may not turn out to be a blessing and instead may become a burden.

Frontiers of Relevance

In addition to the obvious areas of Science and Technology, related to the pressing problems faced by the country in food, health and housing, the three areas of greatest importance for development are energy, transportation and communication. In these areas, we will have to do proper planning for the next decade or two and carry out all those aspects of research and development that are crucial to make progress. We are facing an energy crisis which is likely to continue for some years. Without proper communication and transportation, there will be no social integration in the country, which is essential for progress.

Frontiers of Chemical Science : A Case Study

Chemistry, being a central science, provides the basic understanding that is required to deal with a large variety of needs of our society. Whether it is feeding and clothing our population, tapping new energy sources, improving health and fighting disease or finding new substitutes for the dwindling natural resources, chemistry plays a crucial role. Fundamental research in chemistry will be of great help to the future generations in coping with new and unexpected problems and in answering their needs. Chemistry has been developing interfaces with other science such as physics and biology at such a phenomenal pace that the scope and structure of the subject keep changing continually. It is important to be on constant vigil not to miss opportunities to contribute to new directions and to apply chemical knowledge to answer newer challenges or obtain better solutions to problems.

The subject has grown explosively in the last few years. Chemists have synthesised over 8 million compounds. The doubling time in discovering new chemical compounds is now hardly 10 years, compared to 40 years in the 1940's thanks to new diagnostic tools as well as better unifying theoretical models.

Some of the most important frontiers of chemistry today are :

Synthesis, chemical dynamics, catalysis, theory and computer simulation, chemistry of life processes and new materials.

Let me briefly touch on some important aspects of each of these frontier aspects.

The ability of chemists to design and invent new families of organic and inorganic compounds has surpassed all expectations and the gap separating organic and inorganic chemistry is decreasing. Metallo-organic compounds of controlled reactivity, molecules with clusters of metal atoms, molecules mimicking biological systems are typical of interesting synthetic aspects today. Novel kinds of agricultural chemicals (including sex-attractants and insecticides) and those required for the health of animals (including humans) continue to be of great relevance.

Our understanding of chemical dynamics has increased in the last few years and is beginning to uncover the intricate mechanisms of complex reactions. There is considerable scope to investigate the chemistry of the atmosphere, photochemical transformations, and the chemistry of propellants. Today we are able to examine very fast reactions occurring even in picoseconds. Laser chemistry and plasma chemistry and chemistry of materials under extreme conditions provide real challenges.

Catalysis has emerged to become much more important today because of our ability to design catalysts better and to "see" surface reactions directly by employing powerful instruments. This area includes not only heterogeneous and homogeneous catalysis, but also electrocatalysis, enzyme catalysis and photocatalysis. The study of surface and interfaces is now an important and integral part of chemistry.

Chemical theory has come of age and is able to predict the structure and behaviour of molecules as well as of large systems. Computer simulation and statistical mechanics are indeed areas of great promise. Computers will play an unprecedented role not only in carrying out marathon calculations on structure and reactivity, but also as storehouses of information which will minimize or eliminate much of routine measurements.

It is only in the last few years that chemistry is being recognised as an essential part of modern materials science. Whether they are materials related to new energy sources or polymers for use as structural materials. chemistry plays a key role. Let us not forget that chemistry is itself a materials science. The new high-temperature oxide superconductors are highly complex chemical systems ; even making and processing the well-known "silicon chip" involves numerous chemical operations.

The relation between chemistry and biology need not be emphasised. Chemistry gave birth to many new areas of biology, including molecular biology. Much of the efforts in biology and bio-technology have major chemical components.

We need to give priority to work in the different research frontiers of chemistry mentioned earlier. There should be greater support to chemistry from industry. Let us not forget that most of modern industry has a strong chemical base and the progress of advanced countries has been mainly through their chemical industry.

Investment of government in chemistry and chemistry-based R & D as well as industry (including materials) should be increased commensurate with their importance. Indian chemical industry is hardly 30 years old and is now poised for major growth and it is estimated that investment in this industry during the next 15 years may reach Rs. 70,000 crores or more (excluding downstream processing industries for elastomers, fibres, plastics etc.). It is crucial that we examine our priorities in areas such as fertilizers, petrochemicals, agrochemicals, bulk drugs, polymers, speciality chemicals and biotechnology, taking into account our renewable and non-renewable resource pattern. We have to train better chemists to take up challenging tasks in R & D as well as in education ; we are short of talented chemists.

Advanced Technology Materials : A Crucial Area for Progress

Advanced technology materials have made a tremendous impact on the quality of life of man. The prosperity of a country is almost directly related to the magnitude of use of these materials. In fact, we can employ the usage of advanced technology materials as an indexof development ; clearly, this index distinguishes the developed from the developing countries. The investment on materials industries in advanced countries in the last few years has been stupendous, the turnover of certain materials reaching astronomical proportions. The fastest growing industry today—and probably the most demanding one as well—is that related to materials. Unfortunately, advanced materials have not entered the markets of India and other developing countries. There is also little or no industrial effort in this direction. Yet, the same materials that have been responsible for the progress made in advanced countries are required to improve the quality of life in our country. After all, better transportation, communication and energy alternatives are the crying needs in India and in almost all the developing countries. Let us briefly review some of the important classes of advanced materials.

Polymers have undoubtedly revolutionized our life style. In the world today, the average per capita consumption is 11 kg (compared to a developing country like India where it is less than one kg). Composites made of plastics or reinforced plastics (FRP) are used widely. In the US, composites are used in transport and aerospace applications to the tune of 26% (compared to 5% in India). FRP is used to the tune of 850,000 tons per year in the US and 300.000 tons in Japan (compared to 6,000 in India). The use of FRP in automobiles and other modes of transportation is well known. High performance composites made by using strong fibres (C, B or aramid) are important new structural materials for aircraft and space industry. It is possible that future aircraft will use more than 50% of these composites. Automobiles are likely to use these materials in the future. The paramid (Kevlar) fibres (40% lower in density than fibre-glass) have already made a great impact on the aircraft industry. Carbon-carbon composites have also shown good results and increased potentialities.

Our main *energy sources* have been hydroelectric, thermal and atomic. In countries like India, solar energy is available in plenty and throughout the year. The importance of making of materials for solar energy conversion is therefore obvious. Two means of beneficiating solar energy are photovoltaic or photoelectrochemical. For photovoltaic applications, silicon still remains the most viable material. GaAs and CdS are solar cell materials with special applications. For photoelectro-chemical cells, several oxide and chalcogenide semiconductors have been studied. An economical means of producing H_2 by this route is still not available. Electrochemical photovoltaic cells hold some promise.

Fuel cells (H_2 or CH_3OH) continue to be attractive as energy packages. Stabilized zirconia is a good oxygen solid electrolyte. We are yet to find a good proton conductor for CH_3OH fuel cells.

Hydrogen storage materials have been studied extensively. FeTi and LaNi are two of the candidates for this purpose. *Batteries* (or electrochemical cells) of various kinds have been produced or are being investigated. The most viable ones are still the lead-acid and NiCd batteries. For electric vehicles, the various possibilities are, Pbo_2/Pb, O_2/Zn, O_2/Fe, NiOOH/Fe and NiOOH/Zn. Miniaturized batteries (Ag - button or lithium for example) are being made; lithium intercalation in layered materials (V_6O_{13} or TiS_2) has proved to be effective for making Li batteries. Intercalation chemistry has indeed become a major area of study in solid state chemistry. Reversible electro-chemical doping of polyacetylene enables fabrication of a rechargeable battery.

Crystalline silicon has formed the backbone of much of *semiconductor electronics*. Its applications in computers and various devices are well known. As mentioned earlier, silicon is the only viable material to-date for photovoltaic energy conversion. Amorphous silicon, specially that doped with group III or V elements, seems to be on the threshold of becoming a good alternative in photovoltaic and other applications. By employing heterojunction structures with layers of amorphous SiC, over 10% efficiency has been achieved in large area structures A number of II-VI and III-V semiconductors are used in electronic industry. Special mention must be made of GaAs and Al-doped GaAs which give high photovoltaic efficiencies (>20%). GaAs doped with III and V group elements are good light emitting diodes for optical communication (e.g. $GaAs_{1-x}P_x$). GaS itself can be made by CVD ($AsCl_3$ + Ga) or by the reaction of AsH with Ga and HCl. Hydrides of group V elements reacting with an organometallic such as $Ga(CH_3)_3$ is another method.

High-temperature *superconductivity* has been a dream of all scientists This area has suddenly become promising because of the recent discovery of certain oxides of copper which show superconductivity above liquid N_2 temperature.

This is probably the biggest sensation since the discovery of the transistor. It was first found early in 1987 that oxides of the type $La_{2-x}Sr_x(Ba_x)CuO_4$ possessing the K_2NiF_4 Structure show superconductivity in the region 20-40 K. However, the Y-Ba-Cu oxides exhibit superconductivity above liquid nitrogen temperature ; these oxides are all related to the perovskite structure. There is no doubt that strategies will be developed to produce novel oxides and other materials exhibiting superconductivity at still higher temperatures (possibly at room temperatures). Undoubtedly, solid state chemists will have much to contribute to engineer such materials. Once superconductivity is found to occur at reasonable temperatures, levitation transportation would become practical. Power transmission and development of magnets (for MHD generation) would then be greatly revolutionised. Superconductors will be used widely in electronics (especially in computers).

There is a class of materials called the *ferroics* possessing two or more orientation states or domains which can be switched from one to the other through the application of one or more appropriate forces. These materials include ferroelectric and ferroelastic substances as well. Some of these (e.g., $LiNbO_4$) are important optoelectronic materials. Colour modulation and optical switching are facilitated by ferroelastic materials (e.g., GMo).

There is quite a likelihood that electronics will be replaced, at least partly, by photonics in the not too distant future. Replacement of the electron by the photon has tremendous consequences. Materials development for photonics is an area of great importance. It is noteworthy that methods of synthesis of some of these materials are crucial. Use of organic derivatives as precursors (e.g. oxalates, citrates etc. for the synthesis of PZT and PLZT or even $BaTiO_3$) is an example.

Photonics is likely to have a great impact on the future of computers, communications and laser technologies.

Fibre communication has revolutionized modern communication practice. Generally, pure silica fibre is used for the purpose (140 megabits per sec, over 30 km distance without use of repeaters). Fibres made of heavy metal fluorides are now attracting considerable attention. For preparing high purity silica, the sol-gel route is used with hydrolysable organic derivatives such as tetraethoxysilane. The light sources used in fibre communication are generally Ga-As type III-V semiconductors (e.g., $Al_xGa_{1-x}As$, $Ga_xIn_{1-x}As_yP_{1-y}$) ; a variety of such laser materials are available for different types of applications.

The development of samarium-cobalt and related alloys was a major landmark in magnetic materials. Traditionally, ferrite materials have been widely employed in communication industry. In Japan and US alone, hard and soft ferrites are used to the tune of $600 million a year The newest of the magnetic materials are Fe-Ni-B based amorphous alloys with high permeability, low magnetostriction and high mechanical hardness. The Fe-Nd-B system is the most powerful magnet known hitherto. These as well as the new superconducting materials will undoubtedly usher in a new era in the world of magnetic materials.

Other than the ferrites referred to earlier, a number of advanced ceramic materials are gaining increasing importance. Structural ceramics required for engine systems require high strength, low thermal conductivity, high thermal shock resistance, chemical inertness and other properties. Silicon nitride (Si_3N_4) has turned out to be a good material for high temperature applications ; this can be made by many routes, including CVD and reaction bonding.

Sialon obtained by ingenious chemical substitution of Si and N by Al and O respectively is another such material ; several modified sialons have also been studied. Toughened zirconia ceramics are used for thermal insulation in turbines etc., because of its low and constant thermal conductivity. Transformation toughened zirconia has also found useful applications. Some of the sensor materials (e.g., stabilizer zirconia is an oxygen sensor) also employ certain ceramic materials, mainly oxidic.

We, in this country, will have to work out our requirements of the various advanced technology materials and keep a vigil on this fast-growing area. It may be advisable to have a national co-ordinating and monitoring body for R & D in materials.

Other Frontier Areas

With the advent of inexpensive and powerful microprocessors, it has now become feasible to build a computer by interconnecting a large number of microprocessors. Such a computer, referred to as a parallel computer, can solve problems requiring intense computing. Parallel computers reaching supercomputer capability can be built at a modest cost. The speed of parallel computers can only be exploited if new algorithms tuned to the structure of these computers are developed. Research and development in this area is in its infancy all over the world and we have a good chance of becoming world leaders in software, with great export potential. ☐

(To be continued in next issue)

FODDER, FEED AND NUTRITION

M. V. M. DESAI,* V. K. GUPTA** AND A. K. GANGULY***

FOUNDATION of Indian economy and life has to rest on the four pillars of symbiotic activity of the people and their environs. The four pillars are agriculture, forestry, animal husbandry iucluding wild-life and water & soil conservation. If the plans are implemented to maintain and improve these four vital aspects, then only the progress in all other fields would be possible supplementing improvement in the life of the people. The well being of the environment, economy and nutrition of the people of the country depend upon the health of the livestock population. The livestock, in general, is an important source of energy in the form of work force. More importantly, the milch animals like cows, buffaloes and goats provide vital proteins as milk for the nutrition to the population of the country. It is also recognised that the primary source of meat and mutton for domestic consumption is goats and sheep. Therefore, it would be necessary to improve and maintain the livestock population of the country in good health so that the benefits accruing could be directly helpful in reducing the large-scale malnutrition of the people. An attempt has been made in this article to examine the availability of resources to produce adequate fodder and feed material for the bovine population of the country and also to suggest strategies to meet the nutritional requirement of the people. In this exercise, the basic premise is that any drastic changes in the rural lifestyle in the country would be very difficult to bring about unless appropriate replacement technologies are made available and people are tuned to adopt them.

Live-stock Population

This section deals with the population, growth trends and projections accroding to the present growth trends of cattle, buffaloes, goat and sheep upto the year 2000 A.D. Growth rate of cows & buffaloes appear to be highest in the decade 1951-61 (cf. Table 1) and there is a drastic reduction in subsequent years. The increase in buffaloes population taken alone indicated some consistency throughout the period upto 1973, but the fall in the growth rate of cow population was too drastic to be accounted for by slaughter for beef and leather production only. Perhaps the census figure of 1951, the first ever taken in the country, was not that accurate nor the beef and leather production figures are reliable. Further, the overall drop in the growth of cow population may also be attributed to the non-availability and/or improper distribution of fodder and feed material. The sheep population has remained somewhat steady indicating that the live sheep removed by death or sacrifice are replaced by the new births[1]. The goat population, on the other hand, has shown a steady increase inspite of the fact that about 36% of the live population are sacrificed every year, in addition to the natural mortality, under the prevailing conditions. The sustained growth rate may be attributed to the enhanced birth rate and multiple litters in a delivery.

The technique of collecting census figures for livestock has improved considerably since 1951. For computations beyond 1977, therefore, following numbers are adopted from

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Trombay, Bombay-400 085.

**DAE Safety Review Committee,
Bhabha Atomic Research Centre,
Trombay, Bombay-400 085.

***"Harshanath",
1, Saras Baug, Sion-Trombay Road,
Deonar, Bombay-400 088.

TABLE 1 : Population projection of cattle, buffalo, goat and sheep (Numbers in parantheses indicate female animal population)

Year	Million heads			
	Cattle	Buffalo	Goat	Sheep
1951	155.24 (49.873)	43.40 (21.85)	47.0	40
1961	175.56 (54.204)	51.21 (25.023)	60.8	40
1972	178.87 (56.773)	57.94 (29.553)	67.52	40
1977	180.0 (55.8)	61.96 (30.98)	75.62	40
1980	180.68 (56.01)	64.50 (32.25)	80.93	40
1985	181.82 (56.36)	68.97 (34.485)	90.63	40
1990	182.97 (56.72)	73.76 (36.88)	101.49	40
1995	184 13 (57.08)	78.87 (39.435)	113.66	40
2000	185.29 (57.44)	85.34 (42.67)	127.28	40
Growth rate (% per year) from 1972-77	0.126	1.35	2.29	0.0

1972-77 census as percent growth rate per annum of different livestock :

Cows	0.126%
Buffalo	1.35%
Goat	2.29%
Sheep	0.0%

The projected livestock population in the categories arrived at by using the above growth rates for the years 1990, 1995 and 2000 A.D. are given in Table 1.

Based on the availability of fodder and feed material to sustain the present population of cattle, buffaloes, goats and sheep and the projected population, it has been advocated in many quarters that the population of these animals is too large to be sustained in a healthy and productive state. It would, therefore, seem logical to examine the following questions :

(i) Is the number of animals too large ?

(ii) Is the productivity per animal in terms of work, meat or milk output poor ?

(iii) What should be done to meet the nutritional and work needs of the people of the country ?

Solutions have been suggested from various quarters, including the Government, that for betterment of cattle population and increased productivity, the poorly productive ones should be slaughtered and the breed and feed should be improved. However, there is an equally strong school of thought that the productivity of indigenous cattle (work, milk and meat) is poor essentially due to malnutrition (cf. Table 2). In this context, it should also be realised that a large fraction of cattle, buffaloes, goats and sheep population depend on grazing in far and wide areas to meet the feed requirements, partly due to traditional parctices and partly due to non-availability of feed and fodder in the stable. Another important factor is that the feed requirement, being met by grazing, costs little to the owner of the livestock. The resultant effect of this is on the reduced productivity of the animals, which return to the stable after wasting energy in movement for grazing. The scope for improving the work potential and milk yield of the indigenous cattle through proper feeding has been recognised by the National Commission on Agriculture (NCA), 1976 which states that "the working efficiency of indigenous bullocks can be enhanced by 30% and the milk yield of indigenous cows by 50% by better and scientific feeding."[2] It would, therefore, be worth examining, the strategies to meet the feed requirements of these animals to bring about an overall improvement.

In addition to meeting the nutritional requirement of the human population in the form of milk and milk products and meat and mutton, the management of cattle or animal husbandry for agriculture, cane crushing, oil extraction, cart transport, ploughing are all traditionally integrated in the culture of the productive activities of the vast rural community, forming the very backbone of the country's economy. Therefore, reducing the livestock population without improving the technology

TABLE 2 : Fodder and Feed material : Availability, requirement, shortfall and projected requirement upto 2000 A.D.

Fodder or Feed	Requirement	Availability	Shortfall
	Million tonnes in 1973		(%)
Green fodder	343.57	214.5	44
Dry fodder	347.4	309.0	11
Concentrates	19.5	11.0	38

Requirement Projections upto 2000 A.D.

Fodder or Feed	Million tonnes a^{-1}				
	1980	1985	1990	1995	2000
Green fodder	354.38	362.49	371.08	380.14	389.72
Dry fodder	357.96	366.15	374.83	383.98	393.66
Concentrates	20.14	20.60	21.08	21.60	22.14

for replacement and solely on the reduced availability of feed materials would create severe imbalances in the rural economy and may even prove disastrous for the country. In the following sections, availability of fodder and concentrates and the strategy to meet the feed requirement for the cattle, buffaloes, goat and sheep population upto the year 2000 A.D. are discussed.

Fodder and Feed Requirements and Supply

NCA gives the fodder and feed requirements under three heads viz. green fooder, dry fodder and concentrates[2]—(cf. Table 2). The aggregate of fodder and feed material required for 1973 cattle and buffaloes population calculates to 8.18 kg per day per capita. However, the amount available in the same year was 6 15 kg per day per capita, a shortfall of 2.03 kg per day per capita (24.82%). Table 2 also gives the break up of fodder and feed requirement for the cattle and buffaloes population as projected in Table 1, from 1980 to 2000 A.D. These requirements do not envisage introduction of exotic variety of cattle which are known to consume much higher fodder and feed to give optimum yield in terms of milk, work and meat[2]. The incremental requirements for the three plan periods starting from 1983 over the availability in 1973 are given in Table 3. The availability of fodder and feed material, based on the above premise, would then have to be increased by 82.1% for green fodder, 27.4% for dry fodder and 101.3% for concentrates by 2000 A.D. Aspects related to the production potential and availability of these materials are examined in the following subsections.

TABLE 3 : Incremental requirement in (%) over 1973 availability of fodder and concentrates upto 2000 A.D.

Fodder and Feed	Incremental Requirement %			
	1985	1990	1995	2000
Green fodder	69.39	73.4	77 64	82.1
Dry fodder	18.5	21.3	24.27	27.4
Concentrates	87.27	91.64	96.36	101.3

Dry Fodder

The edible straw and husk from foodgrain production in 1973 was 121 mT.[3] The availability of dry fodder in 1973 was 309 mT (cf. Table 2). It, therefore, follows that 188 mT of dry fodder was available in the form of dry grass and other dry edible materials. In 1985, the edible straw and husk available from foodgrain production of 160 mT of grains is around 200 mT (It is estimated that for each tonne of foodgrain about 1.25 tonnes of dry straw and husks are produced[3]). It follows that to meet the requirement of dry fodder (366.15 mT) only 166.15 mT of dry grass and other dry edible materials are to be made available. If the projected target of foodgrain production of 277 mT in the country in the year 2000 A.D. is achieved[4], the dependence on dry grass and dry edible material to meet the dry fooder requirement will be only to the extent of 47.41 mT. This is far below that was available even in 1972-73. This means that the pressure on grass land and fodder crops will considerably reduce. It would, therefore, be necessary to introduce appropriate techonological, organisational and managerial expertise to take advantage of reducing pressure on grass lands due to progressively higher availability of straw and husk. These actions would help in regeneration of vast grass lands, fodder lands and forests, increasing the green cover in the country.

Green Fodder

The green fodder is available from four main areas of land viz. permanent pastures, cultivable wasteland, forest area open to grazing and area under cultivated fodder crops. NCA and The Handbook of Agriculture[2,5] (HA), 1980 have given areas under three heads a summary of this information is presented in Table 4.

TABLE 4 : Area under fodder crops (1973)

Type	mha	
	HA*	NCA**
Permanent pasture	13	13.3
Cultivable wasteland	15	16.1
Forest area open to grazing	21	36.13
Area under cultivated fodder crops	14.52 (4.4%)	13.86 (4.2%)

* HA : Handbook of Agriculture, 1980

** NCA : Report of the National Commission on Agriculture, Vol. VII, 1976

It is seen from this table that estimates of forest area open to grazing are different by as much as 15.13 mha. Both the Handbook of Agriculture and NCA have also given the average yield of fodder crops, grasslands and tropical & subtropical forests. These are presented in Table 5. NCA has further observed that "for want of survey data, the Livestok Feed and Fodder Committee of the Ministry of Agriculture and Irrigation estimated on an average fodder yield of 50 tonnes per hectare of irrigated and 25 tonnes per hectare of unirrigated area under cultivated fodder land. The irrigated fodder land area is given as 6.5 mha out of a total of 16.5 mha of land area under fodder crop land." This yields a total of 575 mT of green fodder. NCA has also quoted 525 mT, 288 mT and 430 mT as the quantity of extra forages and grasses being available to livestock through grazing. These estimates include grass available to meet the full feed requirement for three monsoon months and half the requirement for the next three post-monsoon months. It is also pointed out that the grasses available during winter rains is not included in these estimates. If the practice of grazing is discouraged in favour of stall feeding, higher production will be obtained.

TABLE 5 : Yield of fodder crops and grass lands

	tonnes $ha^{-1}a^{-1}$	
	HA*	NCA**
Fodder Crop (i.e., perennial grass)	30 - 280 Optm. conditions (N - S)	50 - 70 Seasonal 100 - 150 Special
	75 (W - E)	200 - 300 Hybrid
Grasslands (hay)	4.2 0 55 (with bushes)	4.2 0.55 (with bushes)
Semitropical and Tropical forest	68	

* Handbook of Agriculture

** National Commission on Agriculture

It is assumed here that the forages and grasses are available for grazing from 13 mha of permanent pasture land and 50% of the forest area open to grazing i.e., about 10 mha. Based on these assumptions and taking 430 mT as the available forage and grasses from these areas, the average yield comes to about 18.7 tonnes per ha. In contrast to this, the Handbook of Agriculture has given the yield of grasses in permanent pasture land and forest area open to grazing (tropical and sub-tropical) as 30 tonnes and 68 tonnes per ha. This yield can further be increased to 50 tonnes per ha and 90.5 tonnes per ha if the potential of the land production is properly exploited. the area under fodder crops identifies 15 mha as cultivable wasteland which has a potential of producing about 25 tonnes per ha of green fodder. Based on the above, the total amount of green fodder that can be produced from the above land resources works out to be 2193 mT. This is a very large quantity of green fodder available in the country and we find it difficult to understand the hue and cry being made regarding the shortage of green fodder to feed the bovine population. It is important to note that this estimate of 2193 mT or does not take into account the 575 mT of green fodder available from fodder croplands. It seems to us that the main reasons for shortages of green fooder being consistently indicated in official documents could be due to :

(a) Severe constraints on harvesting and preservation of green fodder for use specially from pasture land and forest areas during dry and non-productive parts of the year. The scope for using 'ensiling' technique for preservation of green fodder, which not only preserves the texture but also prevents loss of nutritive contents of the fodder, is not being exploited.

(b) It has been observed that large tracks having standing dry forage are burnt—a wasteful exercise.

We feel that there is a great demand for an organisation which should be specifically meant to harvest, preserve and distribute efficiently the green fodder throughout the country for stall feeding. This will result in reducing the overgrazing of pasture lands and forest area open to grazing and help in environmental regeneration. As a spin off, the optimum yield potential of forages and grasses from these lands would be realised.

Concentrates

The importance of feeding both working and milch animals with concentrates in adequate quantity is a well-known aspect of animal husbandry. NCA has given figures for concentrate production and availability for 1971-72 (cf. Table 6)[2]. Concentrates are a mix of coarse grain, edible oil cakes, cotton seeds, rice & wheat bran and pulses' by-product. The total production of these materials works out to 45.84 million tonnes, whereas the availability within the country was only about 11.05 mT in 1971-72. This availability is based on 2% contribution from coarse grain, which also form an important part of human diet. It would, therefore, seem difficult to increase the contribution to animal feed from this source. The total production of pulses in 1971-72 was 11.093 mT. Thus the availability of 1.331 mT is about 12% representing pulses by-product in the form of chunni which is used for feeding animals The availability of items 2 to 4 in Table 6 depends "largely on the export policy of the Government of India which changes from time to time", (NCA)[2].

TABLE 6 : Concentrates production and availability for 1971-72
(Requirement : 19.565 m tonnes)

	Million tonnes	
	Production	Available for feed
1. Coarse grain	24.494	0.49
2. Edible oil cakes	3 419	2.769
3. Cotton seed	1.98	1.785
4. Rice and wheat bran	4.852	4.678
5. Pulses (by-products)	11.093	1.331
Total	45.838	11.053

The NCA has observed that "at present, exports of oil cakes and other animal feeds are being encouraged, in many cases by subsidies and concessions[2] (ref. 5 ; pp. 423-424). These animal feeds are required within the country for increasing production of milk, eggs, meat and wool Some of these products are imported at high cost. It can be seen that even in the year 1972-73, when 7,12,000 tonnes of cattle feed was exported, this quantity could have been converted into 1.78 million tonnes of milk, assuming that feeding cows with 1 kg of concentrate mixture over and above maintenance ration, additional 2.5 kg of milk can be obtained. This, taking even the modest value of Re. 1.00/kg of milk, 178 crores of rupees worth of milk would have been produced as against Rs. 43.68 crores earned in foreign exchange." Thus, it appears to us that the malnutrition and lower productivity of milk in the country is due to policy promoted scarcity condition attended with heavy financial losses and malnutrition of the populace.

The NCA has also given figures on the availability of concentrate feed of plant origin for the year 2000 A.D. (cf. Table 7)[2]. It is seen that the availability of coarse grain has gone upto 25 mT in 2000 A.D. as compared to 0.49 mT in 1971-72. Calculated on the same assumption of 2% availability in 1971-72, the total coarse grain production should increase to 1250 mT in 2000 A.D. as compared to 24.494 mT in 1971-72, an impossible task to achieve. If we were to arbitrarily assume that the coarse grain production in 2000 A.D. will be around 50 mT, twice the production in 1971-72 then around 50% would be made available for animal feed. This also does not seem practical because of the attended increase in human population. Therefore, except for items 2, 3 and 4 in Table 7, estimate of availability of animal feed presented by NCA does not look realistic.

TABLE 7 : Availability of concentrate feeds of plant origin in 2000 A D.*

Item	Amount in mT
Coarse cereal grains	25 00
Wheat and Rice bran	5.67
Chunni from pulses	4.38
Oil cakes	42.00
Total	77 05

*Report of National Commission on Agriculture, Vol. VII, 1976.

For the purposes of estimating the availability of concentrate feed, we visualise that there is sufficient scope to improve the availability of oil cakes on the following basis :

According to daily nutritional requirements of fats for an adult, about 55 gm of fats shall be available[6]. Taking 40 gm per day being met by vegetable oil indigenously and assuming 20% oil extraction efficiency, the total oil seed production in country will have to be increased to 62.20 mT in 1990, 69.4 mT in 1995 and 77.5 mT in 2000 A.D., yielding 49.76 mT in 1990, 55.52 mT in 1995 and 62.00 mT in 2000 A.D. of oil cake. Any short fall in oil production to meet the nutritional requirement will have to be met by procuring oil seeds instead of oil, so that the oil cake thus produced will be available for animal feed.

The production of pulses is estimated to be 37.5 mT in 2000 A.D. by NCA[2]. The daily nutritional requirement of pulses for an adult is 75 gm[6]. An average requirement of about 60 gm per day for the entire population of country would mean 23.26 mT of finished pulses or 26.43 mT of whole pulses conumed by the human population. This would leave about 11.09 mT of whole pulses in addition to 3.17 mT of chunni.

Thus on the above assumptions, taking 62.00 mT of oil cake, 14.26 mT of pulses and its by-products, 5.67 mT of wheat and rice bran and 1.00 mT of coarse cereal, a total of 82.93 mT of concentrate feed would be available in the country by the year 2000 A.D. We will revert to this number again. The projected requirement of concentrates for producing the milk to meet the nutritional requirements of the population of the country is discussed in section on 'Milk'.

Nutritional Requirement and Availability

Based on eating habits, the nutritional requirements (animal protein) of the population of the country can be divided into two categories viz. non-vegetarian and vegetarian. The vegetarian population is totally dependent on milk whereas the non-vegetarian population depends partly on milk and partly on fish, meat, chicken, pork, etc. According to NCA the requirement of milk for the vegetarian population for all age groups is estimated to be 300 ml (average) per day per capita and for 70% non-vegetarian population, the estimate is 160-200 ml per day per capita[2]. From these figures, the average milk requirement works out to 202 to 230 ml per day per capita. In addition, according to the Indian Council of Medical Research, the balanced diet for a non-vegetarian adult should include 30 g of fish and meat per day[6]. In the following subsections, the availability of milk, fish and meat upto the year 2000 A.D. is examined.

Milk

The availability of milk has been estimated as 110 ml per capita per day from the production figures of 1973-74 giving a deficit of about 50%[2]. The estimates of milk production have taken into account the contribution from goats. Of the total 20 mT of milk produced in 1966, the contribution from goat is only 5,70,000 tonnes amounting to less than 3%. In view of the uncertainties for milk production figures, the contribution of goats towards milk production could be neglected for the purposes of estimates for availability of milk. It is, therefore, assumed that the entire milk needs of the country are to be met from the yields from cows and buffaloes.

The milk demand for the year 2000 A.D. with the prescribed average nutritional requirement of 220 ml per day per capita is 85.28 million tonnes per year. If the present practice of lower concentrate feed level as obtained in the year 1972 is maintained for the entire livestock population, then the milk production calculates to 26.4 mT in 2000 A.D. a shortfall of 58.88 mT. NCA has observed that "working efficiency of indigenous bullocks can be enhanced by 30% and the milk yield of indigenous cows by 50% by better and scientific feeding"[2] Thus a 50% increase in the milk yield can be realised by meeting the fodder and concentrate feed requirement of the bovine population as given in Table 2. This would increase the total milk yield from 26.4 mT to 39.6 mT, providing only 102 ml milk per day per capita in 2000 A D. This represents a deficit of about 53.6% as compared to 50% in 1973, an increasing trend. It, therefore, follows that there is an urgency of increasing the milk production to an average human consumption of 220 ml/day to meet the nutritional requirement.

TABLE 8 : Milk Production Estimates

Year	Cattle + buffalo population (million)	Milk Production (million tonnes)
1973	237.83	23.20
1977	241 96	23.60
1980	245.18	23.92
1985	250.79	24 46
1990	256 73	25.04
1995	263 00	25.66
2000	270.63	26 40

The population of total cattle was 179 m and buffaloes was 58 m in 1972. Of these the female population in milk is 12.4% for cattle and 26.25% for buffaloes respectively[2]. It bears repetition that one kg of extra concentrate feed can increase the milk yield for the current stock of milch animal by 2.5 kg. We assume further that the milch animal proportion of the respective bovine population remains the same till 2000 A.D. If preferential feeding of concentrates are stipulated for the bovine population in milk for higher level of milk production, i.e. 1 kg of extra concentrate feed per day, then the additional concentrate required calculates to 16.56 mT, yielding 41.41 ml in addition to 39.6 mT of milk which would normally have been produced, giving a total of 81.0 ml. This would mean that 209 ml of milk per day per capita will be available in 2000 A.D., which is coming within the range of nutritional requirements for the population (cf section on nutritional requirements). Thus the total requirement of concentrates calculates to 40.41 mT as compared to the availability of 82.93 mT in 2000 A.D. This requirement can be entirely met from oil cake production leaving sufficient surplus of concentrates as feed for other bovine population.

The argument of the NCA that "it may appear that it will be well-nigh impossible to achieve this much increase in milk production. We, however, like to state that the increase in milk production as proposed by us is technically attainable as discussed in Chapter 29 on dairy development (p. 12, Ch. 28 of NCA Vol. VII). We Would, however, like to emphasise that for achieving the target of milk production, it will be absolutely essential to expeditiously implement the programmes proposed by us for bringing about an all round improvement in the genetic quality of the indigenous stock, their maintenance in good health and provision for proper feeding to enable them to portray their genetic potentiality" is difficult to support. We would rather like to assert that the required amount of milk supply can be attained with the current genetic stock of cattle and buffaloes by improving the fodder and concentrate availability through improved organisational and managerial efforts.

There is a persistent emphasis on mechanisation of agricultural practices, which should remove some demand for the animal power requirement in agriculture progressively. This will alleviate concomitantly the feed requirement for work animals as we have estimated on the basis of the agricultural practices during 1972-73. However, we have not attempted in this article to make allowances for that only in the hope that any improvement in these practices will lead to better nutrition for the bovine population and higher productivity of milk and energy, even with the present genetic stock.

Fish and Meat

NCA has estimated that the per capita dressed fish availability, after a loss of 40%, is 4.2 kg a^{-1} in 1971, 7.4 kg a^{-1} in 1985 and 10.3 kg a^{-1} in 2000 A.D. This gives per day availability as 11.5 g in 1971, 20.3 g in 1985 and 28.2 g in 2000 A.D. It would, therefore, seem that the ICMR requirement of 30 gm per day per capita of fish and meat for non-vegetarian population can be met. However, in view of the varying eating habits of the people and the export needs, it might be assumed that 20 g per day per capita requirement would be met by fish. This leaves about 33% of the requirement to be met from meat. The estimated meat production figures are presented in Table 9. The basis for the calculations for the figures presented in table 9 are :

(i) The present practice of slaughtering 36% of the goat population continues ;

(ii) Constant availability of 111 m kg/year from sheep since the population growth is taken as nil ;

TABLE 9 : Meat production by goat and sheep in 1980, 1985, 1990, 1995 and 2000

	1980	1985	1990	1995	2000
	Million kg				
Goat	291.3	326.3	365.4	409.2	458.2
Sheep	111	111	111	111	111
Total	402.3	437.3	476.4	520.2	569.2
	Meat availability per capita per annum kg a^{-1}				
	0 84	0.82	0 80	0.78	0.76

Calculation :

(1) Goat in 2000 A.D.

127.28 × 0.36 × 10 million slaughter kg per capita = 458.2 million kg

Sheep (taken constant from 1967-68 onwards) = 111 million kg

Total = 569.2 million kg

(2) Meat availability :

1980 : $\frac{\text{402 3 million kg}}{\text{478.1 million population}}$ = 0.84 kg per capita per annum

(iii) an average yield of 10 kg per head from goat population.

Thus, in 2000 A.D., only 0.76 gm per day per capita meat would be available from sheep and goat. The contribution from other sources such as chicken, beef, pork, etc. is not foreseen to be significant. It is, therefore, seen that a deficit of about 9.24 gm per day per capita for the non-vegetarian population would be experienced by the year 2000 A.D.

The NCA, based on the projected availability of fodder and feed have suggested to limit the goat population to 40 million by 2000 A.D. and to improve and increase the stock of sheep. This essentially means increasing the sheep population by a factor of four and improving the breed to yield mutton at least by a factor of eight higher than the present yield of 10 kg/head Both these propositions seem well nigh impossible. In fact the per capita availability of meat and mutton has steadily gone down from 1986 to 2000 A.D. (cf. Table 9) although goat population has increased. The main reason for this deficit is increase in human population. Under the present conditions obtained in the country, increasing the yield of meat per head of animal seems to be the only alternative. This can be achieved in the first stage by modifying the goat and sheep rearing practices such as penn-feeding and limited grazing with muffled mouth for exercise. Penn rearing of sheep is adopted in Rajathan on a limited scale in sheep farms.

Bovines : Indigenous Vs. Exotic

NCA has advocated reduction in the number of unproductive bovines based on the argument that the fodder and feed required to meet the indigenous bovine population obtained in 2000 A.D. (refer Table 1) is too large. The strategy suggested envisages reduction in the indigenous bovine population and increasing the milch population by introducing exotic variety to meet the nutritional requirements with respect to milk. A similar argument has also been put forward for the reduction in the goat population. NCA has, however, not deliberated on the availability of meat and mutton and the requirements of the leather industry. The present estimates of slaughtering of ox and male baffaloes is around 0.5% of the total population.

Under the circumstances it will be necessary to examine the fodder and feed requirements of the bovines in the year 2000 A.D. for indigenous and exotic varieties. The requirements of fodder and feed for indigenous variety to produce milk according to the nutritional requirements, as discussed earlier, are 380 14 ml of green fodder, 384 mT of dry fodder and 40.41 mT of concentrates. These should be compared with the requirements projected by NCA of 590 mT green fodder, 358 mT dry fodder and 58.82 mT concentrates, for partial replacement of the unproductive indigenous varieties by the high productive exotic variety. Thus it is clearly seen that the reduction in the indigenous bovines and introduction of exotic bovines does not reduce the requirement for fodder and feed. On the contrary, the increase for exotic variety is 1.55 times for green fodder and 1.46 for concentrates. In the case of dry fodder, the requirements of the exotic variety are slightly less (7%) compared to that of the indigenous variety. We have discussed in detail the strategy and potential for the production and availability of fodder and feed earlier and we feel that it would be possible to sustain the population of either indigenous or exotic bovines without sacrificing their nutritional requirements. It would, however, be essential that a study is undertaken to identify the changes brought about in the rural and the urban scenario before the introduction of the strategy suggested by NCA.

Grazing Practices

The adverse effects of uncontrolled grazing are many fold worst being hardening of the soil crust so that even from the dung droppings, the manural effect of these droppings is not utilisable The grazing cattle, goats and sheep nimble all the new shoots sprouting out, further reducing the regenerative potential of the land. The seepage of rain water through the hardened top soil is considerably reduced lowering the potential of subsoil water/moisture and increasing the potential of flash floods. It is too often being stressed that India has a surplus population of cattle and domestic animals. It is not fully realised that this growth in population has not been promoted by any Government policy, but by the sheer logic of needs of the farmer, dairyman and those who live by and on the browsing goats and sheep.

Government policy of auctioning the standing fodder/grass crop has contributed considerably towards lowering productivity of fodder and grass. This is because Government looks upon these areas from the point of view of some revenue earning without investment for enhancement of productivity of these land for the purpose. This is an inducement to owners of grazing animals to grazing pastures unprotected and unmanaged. In any case, protection of these pastures by the animal owners has no incentive since any increase in crop yield only adds to the profit of the contractor.

Reference 1, p. 7 points out that as and when the Government came out in the picture with a policy of land reform, the pressure on grazing land has gone up from 39 animal units per ha (51-52) to 105 au/ha (77-78) i.e., an increase by a factor of about 2.7 whereas the cattle population during the same period increased by a factor of 1.16 (180/155). Lack of a coordinated policy or an effort for increase in productivity have led to such incongruities.

Ratio of cattle (including buffaloes) to goats and sheep in 1977 works to 2.07 whereas the damage caused to potentialities of the grass and forest land by the later group far exceeds the damage caused by the former. In the grazing of goats and sheep, no designated area or ownership of land is involved nor the restriction on movement into common grazing land is enforced as much as the owners of these animals do not have any responsibility for fodder production, whereas cattle owners being anchored at one place, there is limitation of the area to which the cattle can be taken to graze.

Extensive migration of sheep and goats and lack of control over the area they graze can be obviated if along the routes of migration (ref. 1) penns are created to contain the animals and fodder is brought to them by the owners. The compelling reason for migration of these animals is the non-availability of fodder and climatic conditions and by grazing them in available fodder land decreases the yield which further complicates the problem of feeding whereas the population is allowed to grow for economic reasons. If these, animals are penn-fed and for exercise, they are allowed to roam in designated locations with muffle faces, this hardship of the tribes due to migration can be minimised to a great extent. However, we are not sure if the practice of migration can be entirely done away with.

It is instructive to appreciate as stated in ref. 1 that only 30% of sheep and goat population in migratory in Rajasthan. Of the 6.54 million sheep in Rajasthan, 0.6 million is migratory (10%). The psychology of relief economics is entirely a wrong approach which puts a premium in favour of unproductive work.

Frequency of drought and flood as given in table on page 13, ref. 1 no longer holds since deforestation and denudation of grass roots have proceeded at fast pace increasing in geometric progression, now we have a higher frequency of drought and flood in all the states and sometimes some of the bigger states suffer from both drought and floods in different parts simultaneously.

All these point out to an agressive progress of desert like conditions in many areas of the country. (page 13, option for future, 2nd para, ref. 1).

Simultaneously with the restrictions in the grazing practices in the country, it is essential that fodder trees such as leucaena and legumes are planted in all parts of the country since the yield/area in trees is higher than from an equivalent area in grass land and some of the trees are amenable to loping and clipping several times a year.

Arranging for fodder development and guarding, it is no solution as we have already seen with our experience in forestry development. People whose interests lie in fodder production have to be enthused to participate in the programme of fodder development and production. If the people are assured by the Government or the power that be that the profits would accrue to them under some cooperative arrangement, then and only then the viable solution would evolve. Key to the solution of the problem is people's participation in the programme wherein the institutions, research organisations and other knowledgeable bodies should participate in transferring their knowledge and techniques to the people at the grass roots. Care has to be taken that people are organised and information communicated to them as to the source wherefrom they can get good scientific information, management methodology and an extensive development of nurseries and demonstration plots. Administrative machinery has to be geared to protect these cooperative efforts from the local vested interest and the mafias. This approach has given very rich dividends to the country in the form of enhanced production of agricultural crops. In our understanding, efforts—scientific, organisational and administrative—for development of forest and fodder land be taken up at par with the efforts put in for agricultural crop production.

Adequate fodder is available tn the country to meet the requirement of animal nutrition and productivity. Further, there is tremendous potential in the country for enhancement of this productivity through concerted scientific and managerial efforts. The need for protein nutritional requirement of the country can be met adequately with the current genetic stock of animals with enough scope for improving upon them for increased production for exportive purposes in the future.

In our discussions, we have not touched upon the problem of water management for better productivity in the forest and grazing lands. In all discussions on water management, irrigation requirements for the farm lands are discussed, which constitute 143 mha of the land mass. The non-agricultural land, mostly denuded now, constitute 123 mha of the land area of the country of which only 30 mha has forest cover. In respect of water management, attention has to be given to conserve all the water that falls in the innumerable number of micro-shed regions of the country and conserving the water falling in the country side in the village ponds and lakes. The strategy has got to be such that water in rainy seasons is not allowed to run off choking and silting up the rivers and tributories, but rather to impound the water so as to allow it mostly to seep through the soil matrix till it reaches the drainage channels. We have not discussed the importance of this requirement in the article for better production of fodder, feed and concentrates. This problem and its solution has been eloquently discussed in a paper by Vohra[8]. ☐

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PARTICLE ACCELERATORS AND THE CHANGING CULTURE OF PHYSICS RESEARCH*

B. B. BALIGA**

THOSE were the days when a lone experimental physicist used to work with his apparatus for hours together and gather relevant data. He hardly had to depend upon others for this work. If one is a bit senior and bogged down with teaching or adminisstrative duties, the students (one or two) used to fulfill the task. In the case of a professor, the senior research students along with juniors used to attend to the chores. Thus one could generally see two to three names in the published work. The group used to be closely knit and the senior most person used to guide and rule. Even if the junior had bright ideas (and if they were accepted by the senior) they used to become part of the senior's thinking. In many cases no recognition of this was even expressed or indicated and the student's main aim was to get his doctoral thesis done (with barely one or two papers published along with his teacher). The experiments in the first half of this century mainly used to be classical topics with optical spectroscopy and X-rays thrown in. In the latter subject too it was possible to obtain data single handedly and the only restriction used to be that the presence of at least another person (laboratory assistant or a helper) was required compulsorily. This was due to the fact that the experiments involved high voltages and there was always the danger of accidents and injury to the worker concerned. But the task of collecting data was that of the research student, and the latter would interprete them in consultation with his teacher.

The new breakthroughs in physics (relativity, quantum mechanics and nuclear physics) at the beginning of the century revolutionised our concepts of physics as a whole and brought in refinements and complications in experimental physics. The picture of a lone researcher toiling in the laboratory at midnight hours was completely wiped out. When the feasibility of particle accelerators was established in the early thirties (of this century) it was clear that the physicist had to call upon engineers (mechanical, electrical and others) to fabricate and run these new tools of his research, leaving him free to wrangle with the physics aspect of the problem. This new culture initiated in the West spread sooner or later to all parts of the world. Today an experiment in physics involves the efforts of physicists, engineers and technicians, whose intense and dedicated labour in unison contributes to the successful completion and achieving of results.

When professor Meghnad Saha proposed the fabrication of the cyclotron in the Palit Laboratory of the Calcutta University, the magnitude of the problem was not envisaged properly nor were thoughts given to the changes in the research culture it was going to bring about. The new experiment of cyclotron fabrication was taken up like any physics apparatus in the classical laboratory by physicists trying to tackle each and every problem faced. Soon it became clear to them that the engineering aspect of the project had to be assigned to the experience of engineers and the vacuum problems faced in the successful running of the machine had to be tackled on a different footing. Though the subject of vacuum was easy to comprehend for the physicists, it required really the tenacity of sharp technicians to develop the skill in leak hunting and making the system vacuum tight. The experience of those early days was such, that bright physicists failed miserably as their patience wore out in leak detection or waiting for the vacuum to be obtained in large systems. On the other hand those who were determined to solve the problem by developing the skill of leak detection, did not find the energy to pursue physics problems, thus ultimately loosing interest and skill in their training as physicists and became only glorified technicians in the laboratory. These pitfalls of the early days were enough warning to organise research in a new way, in the modern research institutes, shorn of teaching and other academic atmosphere. The argument forwarded and favoured in the late forties was that for efficiently conducting research, it has to be taken away from the slow and lethargic atmosphere of the university (in both financing and executing the project). Thus independent India saw a spate of research institutes away from the universities, having laboratories provided with skilled technicians, services of engineers and the scientists.

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With this new philosophy of inter-disciplinary cooperation many an institute did create a congenial atmosphere for research and executed successfully several large projects which could not have been even conceived of, in the early part of the century. However, each system has its own strength and weakness. The conservative attitude of the universities in coming out of their shells to plan and execute large projects is one aspect, but the very soul of the universities in ever interacting with the young generation and constantly replenishing the thinking was absent in the institutes devoid of teaching. Teaching not only imparts knowledge to the young but expands the understanding of the teacher, taking him to higher planes of comprehension with each class. In recent years several institutes have tried to make up for this lacunae by introducing teaching courses in their institues or attaching itself on a voluntery basis with close-by universities. We have digressed a bit from the main theme, let us return to it.

Due to wartime delays in procuring the components and then finding a suitable place for assembling the same in the university atmosphere, works on the fabrication of the cyclotron, in earnest, was started only in 1951 when the Institute of Nuclear Physics came into existence. After a couple of mishaps in the erections, the physicists could realise the improvement in the machine and a new design was planned with double manifold (from the earlier single one). Local fabrication of the massive structure (from the standards of those days) and getting some of the attachments made in its own workshop, the machine became ready in 1958 for operation. The beam was obtained in 1959 but experiments with internal beam were started only in 1960. After a period of good activities during the sixties and seventies (a number of Ph.D. dissertations were completed using the machine) the machine is presently being maintained for occassional uses.

A second cyclotron of similar dimensions (decommissioned from Rochester University, USA) arrived in the country in the mid sixties, found its mooring in Chandigarh at Punjab University after its recipient settled down there, and started operating in the mid seventies, whereas regular experiments started in the late seventies. Presently many neighbouring universities are using it for experiments. In the mean time a number of Cockroft-Waltons and Van de Graafs (small accelerators of nuclear particles) were installed in many institutes and universities. These machine required a small number of crew (mainly trained technician and hardly one engineer) and still the old tradition of small groups (consisting of two to three persons) could conduct an experiment. When extended periods of data taking started coming into vogue (spread over several days without break) naturally the groups grew larger and the number of persons conducting each experiment also increased.

Then the planning of the real big facility started in 1964 when Dr. H. J. Bhabha having held discussions with scientists from all over India for two days, and decided to go for a big cyclic accelerator and another large electrostatic machine for the use of nuclear scientists in the country. But due to the sudden demise of Dr Bhabha in 1966 and the subsequent reorganisation, the project got delayed. It was taken up by the new chairman Dr. Vikram Sarabhai sometimes in 1968 and a team of scientists was sent abroad to select a suitable machine which could be fabricated for the major part in the country and at the same time be sufficiently in the forefronts of accelerator based research in the medium energy nuclear physics (and allied other disciplines). The Sector Focussed Variable Energy Cyclotron was the result of this search—the machine having sufficient flexibility to mould itself to the future needs. The necessary drawings from Berkaley were purchased and local industries were identified to fabricate the machine in the country. It was the first time that some of these industries had faced such a challenging and exacting job for which they had to gear up afresh to deliver the goods to the specifications demanded for the job. It is heartening that some of them excelled in their zeal and provided their share of the equipment better than what we could have obtained by importing. The job of meticulous assembling was started and the first beam in the machine was obtained in the year 1977. It was a symbolic triumph of an experiment where engineers and scientists had worked together to achieve purposeful result of high quality. It was the symbol of building up the self-confidence of the nation as a whole that we belonging to different disciplines could work in unison, complementing each others' contribution to achieve the same goal. This was just the beginning of a new culture which in advanced countries have produced scientific marvels, for example, the precision with which moon landing was done, or planetory probing is being done, or the mating of Soyuz series of space vehicles thousands of kilometers away in space.

To run a machine of such a magnitude, a band of workers consisting of technicians, engineers and scientific assistants is required who have to coordinate their work with high precision and timing. It is true that the scientist himself will propose the problem of research and then analyse the results obtained in the experiment. But this process of getting the results has become more complex and involved. Even if there is one loose link is this whole gamut of actions and reactions, the whole experiment could be reduced to a waste. Thus even from the technicians and engineers the highest kind of concentration in the work is demanded and the research scientist is charged with the additional responsibility of personal management. Whereas in the earlier days it was the case of matching of the temperament of two to three individuals, presently, adjustments, give and take and overall matching of the attitudes of a large number of heterogeneous persons is demanded. The successess of an experiment depends upon how well these qualities have been attended to.

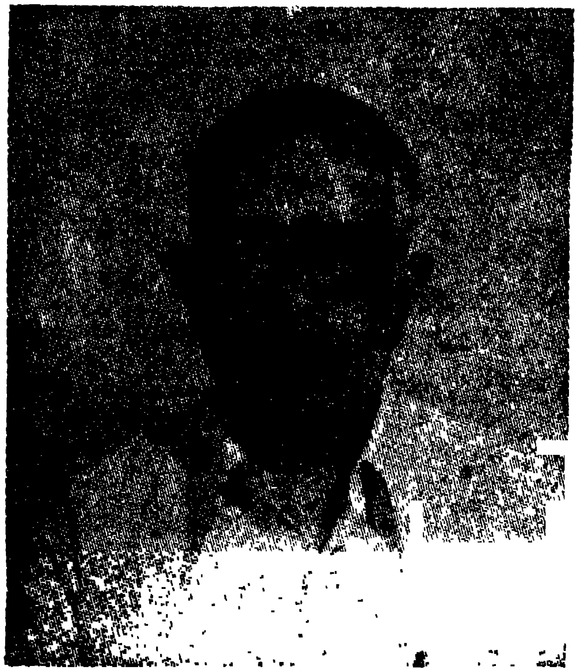
Naturally, it takes time to adopt to the new culture which has to be cultivated. This is especially true with small university groups which want to work with big machines. The culture shock which they get is difficult to bear and, many a time, they end up in unreasonable complaints. Research is a creative activity and requires an inner urge of motivation to achieve results. Persons cannot be goaded to produce results which they are not inclined to. When a large group of intelligent individuals have to work together to produce something which can be appreciated, then the leader of the group has the onerous job of guiding the junior members gently and understandingly, and encourage the colleagues by proper appreciation of the tasks performed. If these skills are utilised properly, it can work wonders since no amount of financial reward can replace a simple sincere appreciation. The leader of the group must have a good understanding of human relationship and must practice modern personal management tactics. More than half the success of experiment depends upon this factor.

Seeing the facilities available at the VECC and realising their role in modern competitive research, demand for more such facilities increased both from the scientists in research institutions and from university quarters. The 14 UD Pelletron facility at TIFR, a joint venture with BARC Bombay and Nuclear Science Centre (NSC) Delhi with similar facility nurtured by the University Grants Commission are the results of such pursuation. The NSC, the epitome of university research in the country is trying to plan its programme for effective utilisation of the available facilities. A number of workshops to evolve concensus to guide the working of the centre were organised all over the country. Majority of the scientists who attended them did so with utopian ideas of research without suggesting any means of achieving the same. Many were the subsidiary facilities which were demanded to be maintained and made available but hardly any group came forward to fabricate and maintain the same for all. This situation has arisen mainly because of the cultural lag discussed earlier. It is absolutely necessary that individual groups should think in terms of coming together (solving whatever minor impediments there are to do so) and manning the needed facility so that by the time the main machine starts operating one or two supporting facilities are ready to assist. It requires mutual trust and understanding, and a bit of sacrifice (especially of ego) on the part of an individual scientist. At the rate at which science is advancing it is not possible for an individual scientist to keep all the information required and acquire the appropriate skills. He has to depend upon healthy give and take with other scientists not only in his own discipline but also, may be, in allied disciplines. To illustrate this point further, take for example a simple scattering/reaction experiment with an accelerator spread over three/four days. First the scattering chamber with multiple detectors have to be made ready. Individual detectors have to be tested and working characteristic studied. If the scattered particles (reaction products) have to be identified then extra detectors have to be arranged and corresponding additional work of setting the detectors. The target sufficiently thin and uniform has to be obtained. To make then it may be necessary to have the assistance of a chemist and one who has developed skills in thin film technique. For charged particle work a high vacuum has to be continuously maintained hence the assistance of a vacuum technician. There is need to attend to the requirement of liquid nitrogen to maintain certain detectors at that temperature and for obtaining high vacuum. The data taking in the experiment goes on for several days and nights, appropriate groups of scientists who understand the overall purpose of the experiment are essential so that data is recorded in a uniform agreed format. Since microprocessors and computers are increasingly used it is comparatively easy but the expertise in this skill has to be acquired. Only after this, analysis and interpretation of the results come in. These are besides the requirements of running the machine, monitoring the radiation level and continuously monitoring the beam. Thus one can see how complicated the experiments have become, but at the same time the information obtained is also quite comprehensive. These developments in the methodology of the experiment itself has brought in greater understanding of the working of nature. The success of this culture, evolving at an accelerator is slowly spreading in other fields of activities. The adjustment in human relations required in this interdependence will bring a better understanding in the society as a whole.

However, as stated, the university departments are a bit slow (cautious may be the appropriate word) in picking up the threeds of this new culture. But the goal oriented research will compel them eventually to accept it. Once the cocoon is broken it will not take too long for this culture to envelope the whole society. After all it is the duty of the University to nurture, develop and advance the appropriate concepts to the betterment of the society at large. ☐

OBITUARY

ANIL KUMAR GANGULY



With the passing away of Dr. Anil Kumar Ganguly, on 17. 1. 1988 India has lost an outstanding scientist of international repute. He was born on November 1st, 1918, at Faridpur, now in Bangladesh. After completing his school education with distinction, he joined Calcutta University for his bachelors & master's Degree in Chemistry, which he obtained in 1938 and 1940 respectively. He worked as a lecturer in chemistry at the Scottish Church College and at the University of Calcutta till 1951, during which period he also carried on research on the cation exchange in silicate minerals, related to soils and clays, obtaining his D.Sc. degree in 1949. Soon after, he joined the University of Notre Dame in the USA and worked with Prof. John Magee. Their joint paper produced the famous Ganguly-Magee Model.

On his return to India, in 1956, he joined the AEE, Trombay, (now BARC) first as head of the Radiation Hazards Control Section, Health Physics Division and finally as Director of the Chemical Group.

Although primarily concerned with radiation protection, he was seriously concerned with the safety of the population at large. His philosophy was that of "Zero discharge". Very early, at a time when ecology was not a fashionable concern. Dr. Ganguly realised that numerous pollutants were vitiating the environment aerobic, aquatic & terrestrial. This prompted him to under-take systematic environmental surveys around major nuclear installations, water quality and sanitation control measurers, the role of humic acids in the environment, and the abatement of industrial pollutants. He worked on the application of radiation chemistry to solve industrial pollution problems.

He is a recognised authority on problems of health and safety connected with nuclear power reactors & environmental problems. He has been invited on numerous occasions, by the International Atomic Energy Agency to visit several countries as advisor. He has championed the cause of clean and healthy environment at innumerable seminars and conferences organised at home and abroad.

He retired officially from BARC in 1978. As a tribute to his long and outstanding services to the advancement of science, the Deptt. of Science & Technology appointed him National Fellow in Environmental Sciences to enable him to continue his work. He was awarded the Padmashri in 1974.

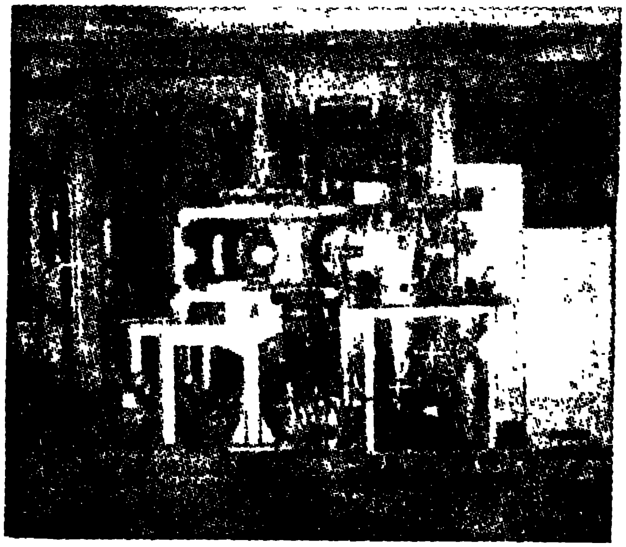
If Dr. Ganguly the scientist was outstanding, Dr. Ganguly, the man, was unparalleled. He had a philosophical bent of mind He inspired affection and respect. His numerous friends, colleagues, students and well wishers expressed their affection & respect by bringing out a felicitation Volume, to honour him for his frontline work in the field of environmental sciences & radiation chemistry. He was a benevolent and kind friend and mentor, and was loved by all those who came in contact with him. □

G. Muthukrishnan

Notes and news

First Tokamak in India

On December 10, 1987, Dr. M. R. Srinivasan, Chairman, Atomic Energy Commission and Secretary to the Government of India, Department of Atomic Energy, dedicated the tokamak to the nation in Calcutta at the Bidhan Nagar Campus of the Saha Institute of Nuclear Physics. Built at an approximate cost of Rs. 2 crores, the tokamak was fabricated by Toshiba Corporation of Japan on the basis of designs drawn up in consultation with the physicists and engineers of the Plasma Physics Group of the Institute. The special infrastructure required for the machine installation at the site was prepared by the Institute.



Tokamak

In the toroidal vacuum vessel of the tokamak, a very high temperature hydrogen plasma (similar to that in the sun) is generated and contained by employing strong magnetic fields. For sustained thermonuclear reactions, from which energy can be extracted by fusion processes, required temperatures of the order of 10^8 degrees or higher. No material container can exist at these temperatures. Tokamak is one of the convenient devices where the plasma can be contained for sufficiently long time and studied with the help of various probes. The greatest set back in harnessing thermonuclear energy is our lack of knowledge of the properties of plasma at high temperature. There are several new phenomena which induce instabilities in the plasma which cool it to low temperature and are real hurdles in attaining self sustained reactions. The scientists all over the world are working to understand the different phenomenon at these high temperature in the laboratory. The concept of tokamak, discovered in Russia, was readily adopted for the laboratory study of plasma in various countries. It will lead to the future fusion reactors for harnessing energy by giving an opportunity to study the hot plasma in its nascent state.

Saha Institute of Nuclear Physics started working in plasma physics, first by theoretical studies in late fifties and later probing plasma in the ion sources. These studies culminated in the febrication of efficient duo-plasmatron ion source for electrostatic accelerators. The interest generated and the group thus built up slowly moved its field of work to hot plasma, a subject in the forefronts of research. With the commissioning of the tokamak the young aspiring workers in the group have ample opportunities to work in this most challanging field of research.

It may be mentioned here that the Institute of Plasma Physics, Gandhinagar, Gujarat is planning to set up a similar machine on a somewhat larger scale. Compared to tokamaks in advanced countries those in ours are smaller but it will be possible to utilise them for meaningful investigations in the basic study of hot plasma.

Teaching and training young people is inbuilt in the very existence of Saha Institute of Nuclear Physics. When the Institute was inaugurated it was with the explicit purpose of training post-M. Sc. students in the art of research in physics. Today many a successful Indian physicist owes his indebtedness to the Institute for initiating him through post-M.Sc. So it is but natural for the Institute to think in terms of starting a training programme in hot plasma, as thermonuclear reactions will be the basis of future energy sources. Thus the Institute has already started to look into the skills and technology needed in the 20th century. □

B. B. Baliga

Science Workshop and Exhibition for Rural Development

A science workshop sponsored by the Department of Science and Technology under science and technology application for rural development programme was organised by Saotia Milanee Sangha at Saotia, Midnapore from March 18-24, 1988. Fifty-three students of rural schools participated and nearly 24 resource persons from I.I.T., Kharagpur ; Indian Astronomical Society, Calcutta ; Haldia Vijnan Parisad ; Gandhi Memorial Leprosy Foundation and others joined the workshop on different days.

Sri K. Bhowmic, Minister, West Bengal Govt. inaugurated the workshop and a science exhibition with telescopes, microscopes, stalls from Fishery and Agriculture Department West Bengal ; Post Harvesting Technology Centre, I.I.T., Kharagpur and others. Indian Astronomical Society ; Birla Museum and Science Museum Calcutta ; Information and Cultural Affairs Dept., West Bengal ; Mass Media, Govt. of India ; USIS, Calcutta helped the organisers with telescopes, microscopes, slides, scientific films and video cassets, and public shows on scientific topics. Nearly 500 students and 2000 people visited the exhibition and public shows every day. The workshop and the exhibition created a notable sensation in the remote rural areas, where it was held. □

S. B. K. M.

Letters to the editor

On seed germination mechanism of *Farsetia hamiltonii* Royle in Indian arid ecosystem

An angiospermic seed may appear simple externally but has a complex ecophysiology for its germination mechanism[1]. Seeds of many species exhibit some kind of inhibition for immediate germination, even when the environmental conditions are favourable for onset of the process. Dormancies of weed seeds and those of arid-zone plants are biologically significant in delaying germination until the environment is congenial for the development and establishment of seedlings. Dormancy in seeds can be caused by characteristics of seeds or by the prevailing environment.

Dormancy, in general, helps the plants to bridge the unfavourable seasons and may be an extension of the system for stopping embryo growth during seed maturation. Amen[2] regarded seed dormancy as an adaptive mechanism of growth cessation which of ten confers upon some species as a selective advantage in distribution and abundance. In weeds, dormancy is often highly developed or it may be that certain plant species have become weeds because of the highly developed system of dormancy they have evolved[3]. A large number of growth regulators have been reported for breaking dormancy of seeds, enhancing their permeability, inducing and hastening their germination[4]. The possible significance of gibberellic acid as a natural factor in germination has been indicated by the detection of gibberellin-like substances in a number of seeds[5]. In the present study, an attempt has been made to observe the seed germination strategies of *Farsetia hamiltonii*. It is the only member of Cruciferae which is found to exist in different edaphic conditions ranging from cultivated fields and sandy plains to sand dunes in the Indian desert. This is also a common weed in Kharif season and an important constituent of sand-dune vegetation. With the onset of monsoon, the plants appear in fields and quickly start flowering and fruiting by the end of post-monsoonal season. However, it almost disappears with the onslaught of arid conditions.

The seeds collected in September 1986 were stored in polythene containers. Seeds are yellowish-brown in colour with papery margin. They imbibed water in a very short time and became mucilaginous. Other seeds characteristics like seed weight, size, imbibition are given in Table 1.

Germination studies were done in sterilized petridishes lined with a single layer of filter paper moistened with distilled water, each petridish contained 10 seeds and were triplicated. The seeds were given the soaking pre-treatment in 0, 5, 10, 25, 50 and 100 ppm of GA, IAA for 24 and 48 hr. The experiments were conducted in a growth room fitted with a light bank (1000 lux) at a temperature of 28 ± 2°C.

Fresh seeds did not germinate in control as well as in any light condition So it was presumed that either some inhibitory factors are responsible for the lack of germination or the embryo lacks the vigour to develop. Such assumption pointed by this study reflected the role of GA in removing endogenous inhibitor.

There was no germination in any light condition. It is evident from Table 2 that GA enhanced the germination at higher concentrations. The maximum germination occurred after 48 hr soaking in 25 ppm. The

TABLE 1 : **Seed characters and imbibition (%) in *F. hamiltonii***

Seed colour	Seed shape	Size of pods (cm)		Seed dimension (sq mm)	Weight of 100 seeds (mg)	Imbibition % (in hr)			
		L	B			1	2	3	6
Yellowish brown	compressed	21.0± 0.7	3.2± 0.83	14.16± 1.47	231.66± 11.54	11.58± 2.1	13.17± 3.13	17.12± 2.45	22.78± 1.43

TABLE 2 : **Effect of different concentrations (ppm) of gibberellic acid and indole-acetic acid on germination (%) of seeds in *F. hamiltonii* (observations taken after 7 days)**

Treatment	Duration of soaking (hr)											
	24						48					
	C	5	10	25	50	100	C	5	10	25	50	100
GA	10.0 ±0	20.0 ±0	20.0 ±0	23.3 ±5.77	36.6 ±5.77	40.0 ±0	20.0 ±0	35.0 ±7.07	40.0 ±14.14	55.0 ±7.07	62.5 ±3.55	96.66 ±5.77
IAA	10.0 ±0.0	0.0	10.0 ±0.0	0.0	0.0	0.0	20.0 ±0	0.0	0.0	20.0 ±0	10.0 ±0	10.0 ±0

C =control

most important role of GA in germination is *de novo* synthesis of α-amylase which hydrolyses starch reserves in the endosperm[6]. Promotory effect of GA in many species was well documented by various workers[7-9]. During the present study also, GA pretreatment brought out maximum germination percentage. It can be concluded that *Farsetia* seeds possess some kind of growth inhibitors. Dormant seeds represent a most important biological adaptation in the arid-zone environment. The membranous wing becomes mucilaginous when seeds were and moistened with water, an adaptive feature of seeds to retain the moisture[10]. *Farsetia* plants can also be classified as drought-escaping ones as they complete their life-cycle during rainy season and almost dry up with the onset of arid conditions. Probably the above mentioned strategies are responsible for the large ecological amplitude of *F. hamiltonii* plants in Indian arid zone.

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Comparison of extracellularly produced enzymes of members of the family Gymnoascaceae

The dermatophytic fungi produce certain diffusible substances in their process of colonization to the superficial layers of skin. These diffusible products are, beyond doubt, the enzymes[1]. Numerous reports on assay of the enzymes produced individually by these dermatophytes are available. But, only few[2,3] make a comparative study of the enzymes of these organisms.

The paper describes the screening of enzymes produced by three members of Gymnoascaceae in a common basal medium. *Trichophyton rubrum* and *Microsporum gypseum* are two known human pathogenic dermatophytes and third one, *Rollandina capitata* is saprophytic. Being an opportunistic fungus, similarity in the profile of its enzyme production may identify its hidden pathogenicity.

A strain of *Rollandina capitata* was obtained from the American Type Culture Collection, Rockville, Maryland, U.S.A. ; the strains of *Trichophyton rubrum* and *Microsporum gypseum* were isolated from patients at the School of Tropical Medicine, Calcutta, India. The organisms were grown on potato-dextrose-agar medium for 2 weeks at 30° ± 2°C. This resulted in heavy growth of the fungi with accumulation of spores at different clusters. The cultures at this stage were preserved at

4°C and served as the source of primary inoculum. Transfer into fresh media was done routinely.

Fungi were grown in the modified Sabouraud's broth[4] for 10 days for assay of the enzymes. Dextrose in the Sabouraud's broth was replaced by starch to avoid interference of reducible sugar (glucose) on the assay system[5]. As several carbohydrates and amino acids inhibit protease production[6], a synthetic medium was selected for protease assay with the following constitution : casein powder, 10 g ; KH_2PO_4, 0.7 g ; K_2HPO_4, 0.3 g ; Mg SO_4, $7H_2O$; 0.5 g and yeast extract, 1.0 g in a litre of distilled water, pH of the medium was adjusted to 6.0.

Culture filtrates were separated from the mycelial mat by filtration. The filtrate was then centrifuged at 10,000 rpm for 20 min. in a cold centrifuge to get rid of mycelial debris. The supernatant was stored at −5°C and used for enzyme assay[5]. The enzymes assayed include α-amylase, L-asparaginase, lipase, protease ribonuclease and urease. Amylase activity was determined by the method of Noelting and Bernfeld[7]. Asparaginase activity was obtained by estimating the amount of ammonia formed in the presence of the substrate asparagine.

Lipase estimation was done by the method described by Bier[8]. Protease estimation was performed by the method of Anson[9]. MacDonald's[10] procedure was followed for ribonuclease assay.

The Units of the enzyme amylase, were expressed in terms of saccharolytic Unit, was that amount of enzyme liberating 0.1 mg of maltose in 3 minutes.

Asparaginase activity was expressed as μg of ammonia liberated per ml of culture filtrate in 1 hour. The ammonia content of the reaction mixture was determined by indophenol method[11].

Lipase was assayed, after titrating with standard alkali ; 1 ml equivalent of N/50 NaOH solution was considered to be 10 lipase Units.

1 Unit of proteolytic activity was considered as the amount of enzyme which liberates 1 μmol equivalent of tyrosine under experimental conditions.

In ribonuclease assay, colour development was done by orcinol reagent[2]. The activity of ribonuclease was expressed as μg of RNA solubilised per ml of enzyme per minute.

Urease was also assayed by the indophenol method of Kaplan[11].

Three organisms showed their unique similarity in having no urease activity and a very little lipase activity (Table 1). *R. capitata* differed from two dermatophytes in possessing low lipase activity and very high α-amylase activity. The dermatophytes completely lacked the extracellularly produced amylase.

On the other hand, the organisms exhibited their proximity in the evolutionarly ladder in possessing asparaginase, lipase and ribonuclease activities (Table 1).

Extracellular production of all the enzymes under present scrutiny were observed in *T. rubrum* and *T. mentagrophytes*[13]. However, some reports[14-16] were unable to demonstrate amylolytic activity in dermatophytes which has been confirmed in the present investigation. This might be due to the poor secretion of amylase in the medium as was reported for some keratinophilic fungi[17].

Further it was reported[4,16,18-20] that *T. rubrum* lacks the capacity to produce urease in glucose-peptone medium. The present finding supports the above observation. However, Tate[21] could demonstrate the presence of the enzyme in certain keratinophilic members of Gymnoascaceae.

Very little lipse production by the

TABLE 1 : Determination of extracellular enzyme activities of the members of the family Gymnoascaceae on the 11th day of their growth

Medium	Enzyme	Substrate	Organisms		
			R. capitata	*T. rubrum*	*M. gypseum*
Starch (4%), Peptone (1%)	α-Amylase (Units)	Starch (1%)	63	—	—
Modified Sabouraud's (Glucose-Peptone)	Asparaginase (µg/ml/hr)	asparagine (0.01 M)	84	54	70
Modified Sabouraud's (Glucose-Peptone)	Lipase (Units)	Emulsified Olive oil (5 gm/100 ml)	09	17	15
Modified Sabouraud's (Glucose-Peptone)	Ribonuclease (µg/ml/Min)	RNA (4 mg/ml)	52	18	18
Synthetic medium (Casein, KH_2PO_4, K_2HPO_4 $MgSO_47H_2O$ & Yeast Powder)	Protease (Units)	Casein (1%)	32	54	59
Modified Sabouraud's (Glucose-Peptone)	Urease (µg/ml/hr)	Urea (3%)	—	—	—

—, Indicates no enzyme production

organisms in the present investigation could be due to frequent sub-culturing for the maintenance of fungi[22].

Asparaginase secretion by all the three members of the family confirms the validity of placing them under Gymnoascaceae as was suggested by Nakahama *et al.*[23] Identification of extracellularly produced protease and ribonuclease from these organisms explains closeness in the same evolutionary ladder. These enzymes can presumably contribute to fungal colonization in different ecological niches. Difference in the lipase and amyalse secretion by *R. capitata* from the two dermatophytes investigated might have been due to its saprophytic nature although reports of its isolation from clinical sources are also available[24].

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Studies on the detection of Carboxylic acids by using triphenylmethanes—Part I

Diamine, triamine and phenol derivatives of triphenylmethanes are known as synthetic dyes, which are used as staining reagents in bacteriology, as taxtile dyes and as an indicator in chemical analysis. Diamine and triamine derivatives of triphenylmethanes are reported as colourless free base having carbinol structure Fig. 1(A). Also after loosing one water molecule free bases have showed Quinene structure, having light red colour[1]. In either case, an acid will convert them to the salts with the original hue. As the solubility of these bases is good in fatty acids, the later are used as one of the important components in the dye formulations to be used as typewriter-ribbon dye, copying-paper dye, ballpoint pen inks, printing inks and Lacquers. It is reported[2,3] that N-substituted auramine in free base form is a stable colourless compound which turns a deep colour when brought into contact with an acid like the carbinol of triphenylmethanes. This unique property is being used to develop colourless copy papers and thermo- or pressure-sensitive recording systems.[4,5] As shown in Fig. 1(B), the chromophoric group of the quinonoid ring is reduced by hydrogen to result into leuco form[6].

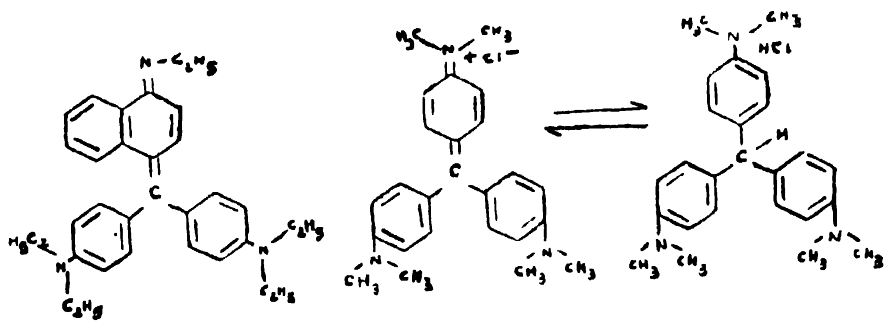
For present work, to establish structural correlationship of carboxylic acids with the colour developed by leuco dyes. Basic Fuchsin (C.I. 42500), Brilliant green (C.I. 42040), Crystal Violet (C.I. 42555) and Malachite green (C.I. 42000) were used. The saturated mono- and dibasic-acids, hydroxy- and keto-mono basic acids and unsaturated mono basic acids are used. All the dyes were of laboratory grade and all the acids were used of Analytical grade. The leuco dyes prepared by the method reported elsewere[7]. Thus, 250 mg of dye was dissolved in 100 ml warm triple distilled water. 1.5 ml of 2 N HCl soln was added and followed by addition to 2 gms of $Na_2S_2O_5$. The mix was shaken thoroughly for about a minute and left over-night in cool-dark place. To the resultant mixture added more HCl soln until the mixture when dried on a glass did not show

TABLE

	Basic Fuchsin (Pale Yellow) pH ≈ 2.22		(Grilliant Green pH =
	After mixing	After 15 min	After mixing
***Saturated Monocarboxylic Acid :**			
Acetic acid (Glacial)	Pale Orange	Deep Orange	Colourless
Propionic acid	Orange	Caremine red	Colourless
n-Butyric acid	Orange	Caremine red	Colourless
Iso-Butyric acid	Orange	Deep Orange	Pale green
n-valeric acid	Pinkish orange Yellow	Deep pink Yellow	Blueish green Colourless
Iso-valeric acid	Orange Yellow	Pink Colourless	Light green Colourless
***Saturated Dicarboxylic Acids :**			
Oxalic acid	Yellow	Yellow	Colourless
Malonic acid	Light orange	Light orange	Colourless
Succinic acid	Yellow	Yellow	Colourless
Glutaric acid	Yellow	Yellow	Colourless
Adipic acid	Yellow	Yellow	Colourless
***Unsaturated Monocarboxylic Acids :**			
Acryiic acid	Yellow	Yellow	Colourless
Methacrylic acid	Orange	Deep pink	Colourless
Senecioic acid	Pale yellow	Light Orange	Pale yellow
***Keto Monocarboxylic Acid :**			
Levulinic acid	Light pink	Deep pink	Pale green
***Hydroxy Monocarboxylic Acid :**			
Glycolic acid	Colourless	Caremine red	Colourless
DL-Lactic acid	Light Orange	Light pink	Yellow
L-Lactic acid	Pale Orange	Pink	Pale yellow
DL-2-Hydroxy butanoic acid	Pink	Caremine red	Light green
DL-3-Hydroxy butanoic acid	Deep pink	Caremine red	Pale green
4-Hydroxy butanoic acid	Deep pink	Caremine red	Light green

1.

(Colourless) 1.90	Crystal Videl (Colourless) pH = 2.35		Mala chite Green (Pale Yellow) pH = 2.05	
After 15 min	After mixing	After 15 min	After mixing	After 15 min
Pale Green	Colourless	Light blue	Pale Yellow	Pale Yellow
Pale Green	Colourless	Violet	Pale Yellow	Light Green
Light Green	Blue	Deep indigo blue	Pale Yellow	Light Green
Green	Deep violet	Deep violet	Light blue	Light blue
Deep green	Blue	Deep violet	Blueish green	Deep blueish green
Colourless	Colourless	Colourless	Colourless	Colourless
Deep green	Blue	Deep violet	Pale green	Blueish green
Colourless	Colourless	Colourless	Colourless	Colourless
Light green	Colourless	Colourless	Pale Yellow	Pale Yellow
Light green	Colourless	Colourless	Pale Yellow	Pale Yellow
Light green	Colourless	Light blue	Pale Yellow	Pale Yellow
Light green	Colourless	Colourless	Pale Yellow	Pale Yellow
Light green	Colourless	Colourless	Pale Yellow	Pale Yellow
Light green	Pale blue	Purple	Pale Yellow	Light green
Light green	Pale violet	Deep violet	Pale Yellow	Light green
Light green	Light Yellow	Light Yellow	Pale Yellow	Light yellow
Green	Light yellow	Light Yellow	Pale Yellow	Light green
Light green	Light green	Greenish Yellow	Colourless	Colourless
Yellow	Light Yellow	Green Yellow	Pale Yellow	Light green
Colourless	Light Yellow	Light blue	Pale Yellow	Light green
Green	Light blue	Deep violet	Light green	Green
Colourless	Light blue	Deep indigo blue	Light green	Green
Green	Indigo blue	Deep violet	Green	Green



(A) (B)

Fig. 1

dark colouration. It was filtered to collect colourless to pale straw coloured filtrate. The pH of the dye reagents was 1.9 to 2.4. The prepared reagents were remained active for few days through stored in brown coloured airtight stopper bottles.

The prepared dye reagents were treated in small quantity with acids, either in liquid or solid state. The solid acids were not dissolved in organic solvents like methanol, acetone, chloroform, solvent ether, atc., as these solvents were interacting with dye reagents to develop dark colour. The development of colour was recorded in two stages ; vide ; (1) after mixing dye reagent and an acid and (2) after 15 min as in many cases colour development was observed after 10-15 min. Also, results are reported in some cases as upper layer and lower layer colour, because the acids were not miscible with the dye reagents. The dye reagent has formed either upper layer or lower layer depending on the density of acids. It is observed that the most of the dye-reagents have showed deep colouration other than the original hue when interacted with acids. It can be, therefore, concluded that these dye reagents are highly suitable for the chemical detection of carboxylic acids. On the basis of the results available (Table 1), it can be noted that it is very difficult to establish structural correlationship of the carboxylic acids and the colour developed by the dye reagents.

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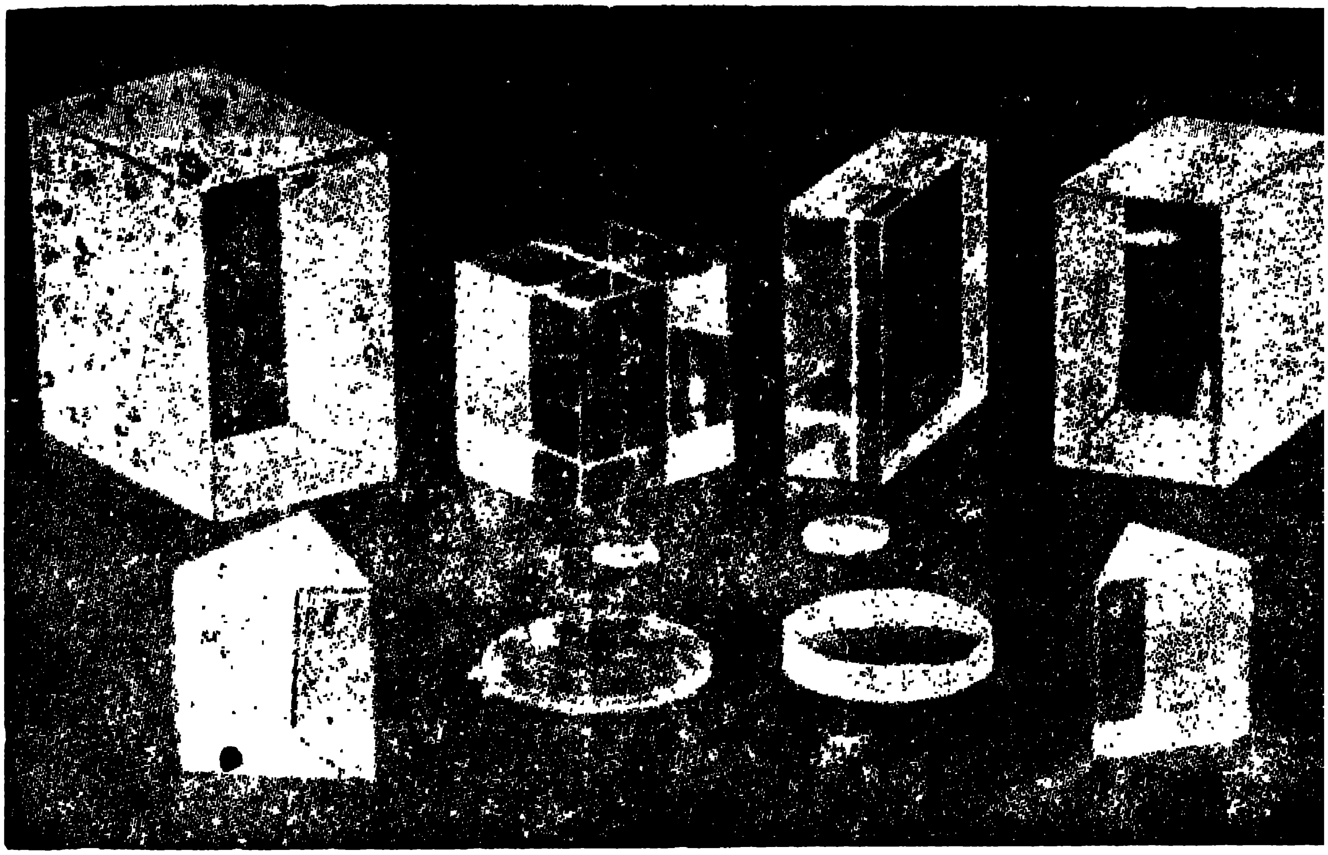

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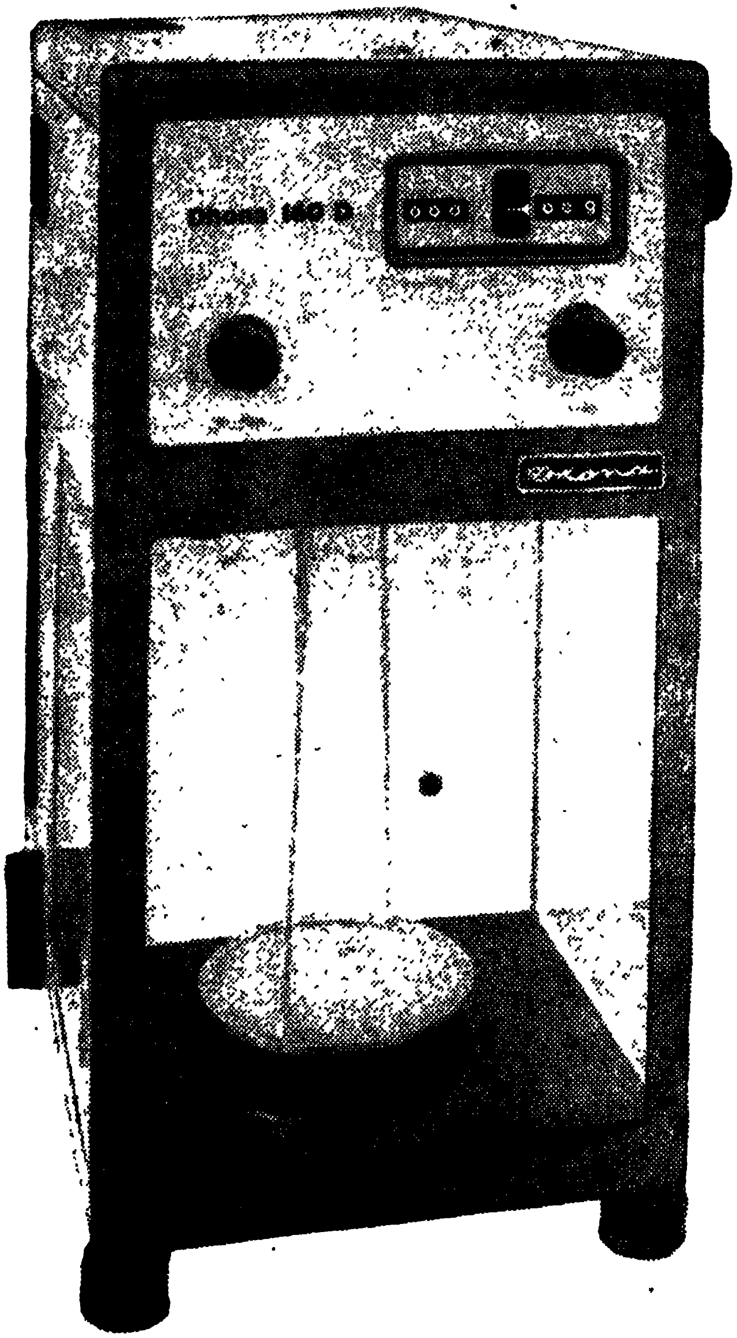

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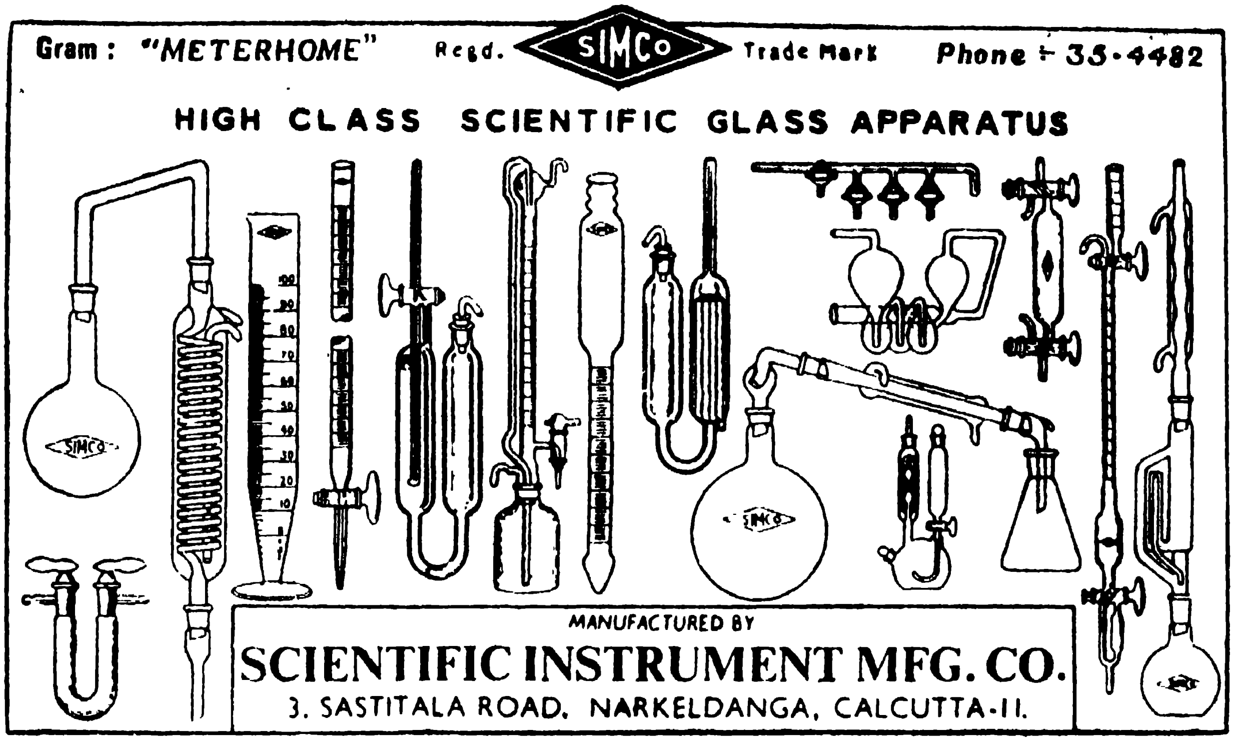

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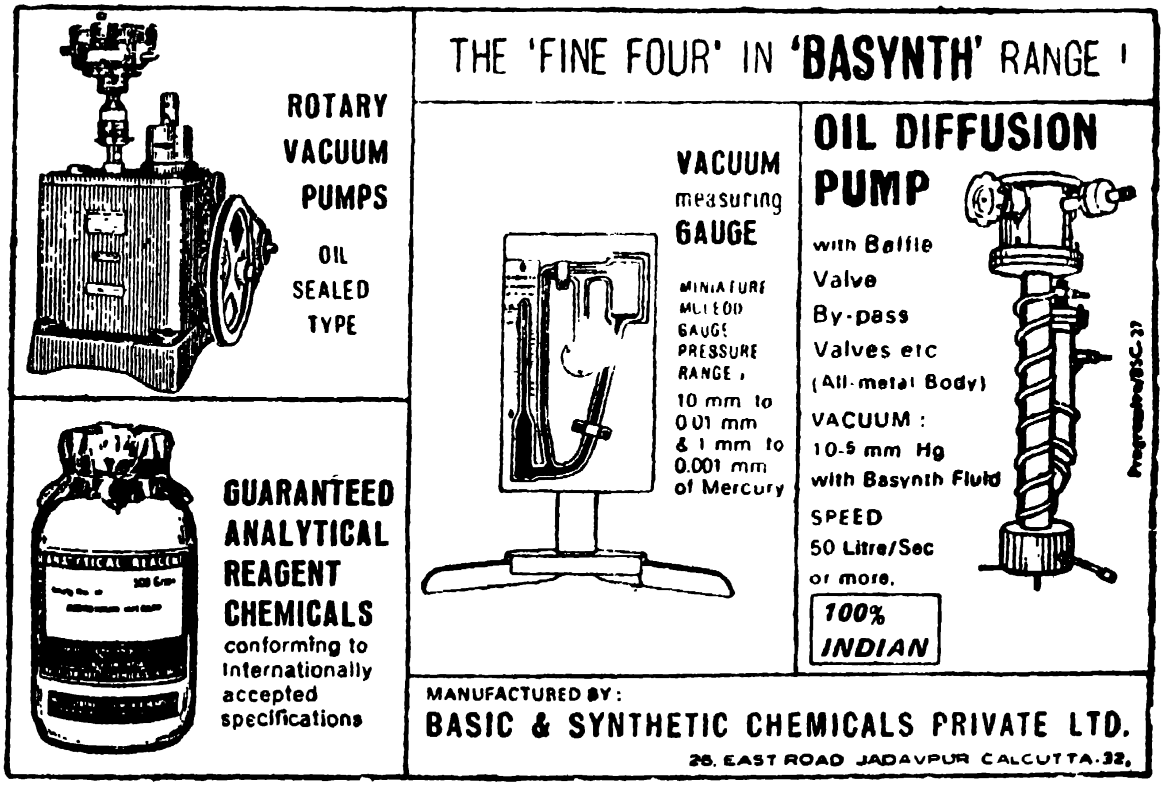

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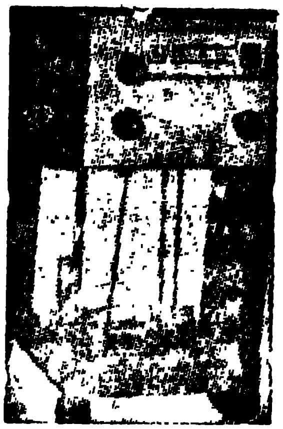

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FRONTIERS OF SCIENCE AND TECHNOLOGY: THE INDIAN CONTEXT

C. N. R. RAO

(*Continued from last issue*)

Issues in Higher Science Education

THERE is so much written about higher science education in the country that there is probably little new that one can add. Higher science education today presents a rather discouraging picture. There are serious complaints at all levels about the lack of responsiveness in the system. Academic activities are at a low ebb. Several factors of a complex nature have contributed to the present condition. Some of the factors are related to processes and pressures in our society, and therefore, reflect the social features prevalent in a particular region. However, there are several aspects where planners, administrators and teachers can do much.

We cannot consider the problems and challenges of higher science education without reference to the problems faced in school education. Inculcation of the scientific attitude in students is most essential in the early school years. It is also important that there is a proper vocational stream available at school level so that all students do not rush towards higher science and technical courses at college level. In spite of the various problems we are facing in science education it must be admitted that many good students still come out of our school system, and a good percentage of them do extremely well in scientific and technical professions. However, in a large majority of schools in the country, the quality of training and facilities are inadequate, and we have to bring them up to a reasonable level.

The common problems associated with undergraduate science education are well known. Undergraduate education is concentrated in colleges, many of which are underequipped, overcrowded and poorly staffed. Laboratory and library facilities are generally inadequate; proper text-books are not available. The level attained by a B.Sc. in India today is much inferior to that of a graduate in advanced countries. It is at the undergraduate level that there is a sudden gap in the quality of education. While there are some select centres where the quality of post-graduate science education is reasonable, similar undergraduate centres are not available for bright students who want to take up science. Undergraduate curricula are rigid even in the best of places. Combinations such as PCM and CBZ do not provide the necessary breadth or depth. The absence of flexibility has made it impossible for a good student to obtain sound, well-rounded training. For example, a physics student cannot study biology just as a biology student can never study mathematics or physics. We have to make flexible programmes available and ensure that all science students have adequate background in mathematics and biology.

All those who take science courses at the undergraduate level are not necessarily going to be scientists. It is, therefore, important that we have at least two streams in science education — one of a general nature and another of a specialised nature (for those who want to be scientists). The absence of such specialised training opportunities is making our undergraduate science education not so meaningful.

In another 15-20 years, undergraduate enrolment may get doubled. Can we even duplicate the present facilities (however poor)? Selectivity is obviously important. We have to find ways of tapping the best talent in the country for science and provide the best possible training to talented students in selected institutions. Present efforts in this direction are inadequate.

Many of the problems mentioned with respect to undergraduate science education also hold for post-graduate education. There are too many institutions offering post-graduate education in science. Most of them are under-equipped and poorly staffed. I see no point in producing such a large number of M.Sc. graduates; the number of people trained at the Master's degree level should have some relation to national manpower requirements.

University departments are expected to carry out research. Although some good work has come out of the universities, it would not be wrong to say that most university departments have poor facilities. They are also short of highly qualified and motivated teachers. Nowadays, research support to individual scientists is quite satisfactory. Institutional infrastructure is generally unsatisfactory. Shortage of student accommodation and ameneties, poor electricity and water supply are common. Unless the universities have sufficient strength to support higher education and research, the support we may give to individuals or departments would not yield maximum benefit. It is important that universities get more basic bread and butter funding. It should be possible to give a reasonable percentage of research grants as overheads to universities, plan budgets allocated for science in the educational sector being too meagre for the purpose.

Even in an advanced country like the United States, people are concerned about the decreasing quality of instruments and other facilities even in the major universities in order to carry out advanced research in science and technology. Scientists in Britain are worried about the competitive capacity of their universities. We can imagine how serious our problems are.

We can make a large number of recommendations, but there would be nothing new in many of them. Many such recommendations would cost enormous money and it would be unrealistic to expect all of them to be accepted or executed. Some important action plans, however, would not require much money, but would rather require our determination to improve the quality of education. I list some of them here at the cost of some repetition. *Admission to the science specialization stream should be made selective; students in the special stream in undergraduate education must get the best possible science education. A few model undergraduate science institutions should be supported in each state to attract students for science just as IIT's and Regional Engineering colleges have been attracting students for engineering education. The facilities and capabilities for certain established major institutions (such as IISc, IITs, TIFR) should be used to start a few model programmes. Universities should not be made responsible to conduct undergraduate examinations. Separate examination boards of groups of colleges should conduct these examinations. Text-books in all subjects (at school and undergraduate levels) should be made available to students. Colleges must have several copies of text-books in the reserve sections of libraries. Computer facilities and formal training programmes in computing must be made available in each major town or city, if not in each school or college, so that youngsters can get adequate training. Design and fabrication of instruments for teaching and research have to be promoted in a major fashion. Individuals and departments involved in instrumentation activity should get special support and recognition.*

In view of the exploding frontiers of knowledge, better ways of training and re-training science teachers will have to be explored. Ways have to be found for attracting better scientists and engineers to the teaching and research profession. Support to select departments under the different programmes of the University Grant Commission should be enhanced. It would be desirable to support research units of outstanding individual workers on a long-term basis.

Manpower Training

We have a great shortage of manpower in many specific sectors of advanced science and technology in the country. This is even true of experimental physics, let alone areas such as computer science, turbomachinery, robotics and other branches of engineering. At the same time, we have a large number of unemployed or underemployed graduates (and even Ph.D's). This mismatch in manpower training has to be tackled in order that we become competent in science and technology in the next decade. The highly trained manpower required by the year 2000 AD has to produced now. We should not forget that the training we impart to students is extremely important because the young graduates of today are going to be the senior managers in the next 15 years or so. We in the Universities, therefore, have a major responsibility.

Because of the absence of highly skilled manpower in crucial areas of science and technology, we should seriously consider deputing a reasonable number of young scientists abroad for short periods (of a year or less) for training in well-defined areas in properly chosen institutions. We should give them a guarantee that when they return after training, *they will have a suitable job with professional challenges.*

Role of Scientists

Where are we with respect to the frontiers of science and technology? Have we done well? Are we world leaders in some areas? Common people ask why we do not have many peaks of excellence in spite of the high investment in science and technology in the last few decades. It is true that we have very few peaks of excellence both in terms of men and in terms of institutions. This is not because of insufficient funds and facilities alone. It is at least partly because of the rather depressing atmosphere that we scientists have created for ourselves while doing science. We easily compromise to mediocrity like in other aspects of life —and mediocrity breeds mediocrity. Tolerance of mediocrity is the biggest killer of good science.

It is true that even when we do good science, it is extremely difficult today to be known for any contribution in science, especially from a country like India. There seems to be an inbuilt prejudice against the work coming from countries like India. However, we cannot accept such a situation and stop trying to do the very best. We have to keep fighting the situation until this country and the scientists here find a place in the sun. We have a few scientists who, in spite of the problems in India, have struggled and fought the situation and have been noticed in the world; the number of such scientists may be small. We often talk of poor facilities, infrastructure etc., but they alone cannot be responsible for the status of science since even in theoretical areas we have not done as well as we should have. We have had only one Ramanujan. I believe therefore that we have to look into some basic causes responsible for this state of affairs. This can mainly be traced to ourselves, namely, the scientific community. Only we scientist and engineers can usher in excellence in science and technology.

Those of us who are in the latter half of our careers have the responsibility to see that the future is secure for science. We have to encourage the right-minded young people and motivate them properly. We should see that they get the right facilities and encouragement. I am convinced that it is not merely salaries that attract young people to science. Opportunities to do good science and a proper working atmosphere are equally important. I do not think that I would be completely wrong if I say that we senior scientists have not done enough to see that the atmosphere is truly conducive for scientific work. We cannot just blame the government for all ills. When some of us talk discouragingly about science (and scientists) and we ourselves are most of the time depressed, I do not think that young people will get enthused to take up scientific professions. It is much better for them and more lucrative to sell soap than take the hard path of science. In addition to providing the right atmosphere, senior scientists have also to set an example in not compromising to mediocrity in everything they do.

Role of Teachers

Many of us scientists are also teachers. In my own career, I have throughly enjoyed teaching undergraduate and post-graduate students. I do not know if I have really tought something to my students, but I know that without them I would have not found my research purposeful. Young people around us not only keep us young and thinking, but also contribute new ideas and hard work. I have no doubt that the young Indian talent has contributed in a significant way to advanced scientific research in many parts of the world.

A teacher's influence on his students lasts for a lifetime. The influence is not limited to scientific activities, but encompasses many aspects of life. This is important since excellence of a person manifests itself not merely in scientific research.

What remains in the student's memory and in his character is the stamp of personality of the teacher rather than the repertoir of knowledge. We generally assume that a teacher must be a master of some subject. While that is an essential quality, it is not the criterion that has been responsible for the lasting influence of many a great teacher on their students. I would like to quote from a talk given by Lord Ashby:

> "The chief quality that distinguishes a teacher is a determination and the skill to build bridges between the two generations, to establish a lively communication with the young. The commitment of a teacher is not solely to transmit knowledge; it is to transmit a tradition of scholarship, an attitude to pheneomena, a particular style of integrity."

The fruit of learning, after all, is not a book but a man. I strongly believe that this message has much to do with many of the issues that we are concerned about.

Role of the Science Congress

The Science Congress itself has a major role to play in the scientific life of the country. It is one occasion when a large number of citizens interested in science gather together. We have to make use of this tremendous possibility to transform not only Indian science but also our society. We have to use the Science Congress to inculcate scientific temper in our society. The Science Congress would also provide an appropriate forum to inform the public of the various developments in science and technology. Students, teachers and citizens should attend Science Congress sessions to listen to lectures given by authorities in simple terms. In addition, it is also the time to discuss with young people and teachers regarding communication in science. Tutorial symposia, therefore, would be of great importance. The Science Congress should also be a place where voluntary science organizations meet annually and chalk out their programmes, share their experiences and plan for the future.

It is my personal belief that it is only through voluntary movements that inculcation of scientific temper, promotion of literacy as well as health and welfare measures will become successful. Government at the centre and in the states can only do so much, but I do not think that by just investing money in sectors such as education and health, we will get the desired results; the community has to gather itself and participate in people's movements in these essential areas.

Role of Government

There is much for the Government to do in promoting the frontiers of science and technology. The various government agencies will have to take proper measures for supporting excellence and for adequately supporting the broad base required for carrying out research and development. We cannot have simple egalitarian principles applied to promote science. Funding in a routine manner is counter-productive. Science funding should not be governed by the whims and fancies of individuals or of government departments but should be based on a national policy. Something like a National Science and Engineering Foundation should probably be established in the country to examine how best we can fund scientific research.

The government has to eliminate, or at least minimize the tremendous bureaucracy in educational and research institutions. The oppressive bureaucracy in our institutions has been particularly frightening and has chased away many a good scientist from the path of science. True autonomy (especially in financial matters) has to be granted to our scientific and educational institutions.

In 1989, we celebrate Panditji's birth centenary. It would be in the fitness of things if all the government departments, agencies and ministries dealing with science, technology and industry as well as our scientific and educational institutions (including our national laboratories) were to come out with carefully prepared perspective plans (for a 15 or 20 years period) which review their accomplishments, present status and future plans. The plans have to be prepared based on intensive discussions among all the working scientists in the organization. This exercise would also be useful to our 8th Five Year Plan. Furthermore, it would be the best tribute we can pay to Panditji.

Agony and Ecstasy

It is my belief that in fundamental science, the choice of a research problem mainly determines the quality of research. This is because, if one has a good idea, it is always possible to find ways of testing it. In fundamental science, one has to pick the right problem to be noticed. In applied science, we have to pick problems that yield most benefit.

The difference between first-rate and second-rate research is often very small, and a little more effort can transform second-rate work into first-rate work. However, many of us often prefer to do repetitive work for various reasons rather than do something novel or new. Even under these difficult conditions, those who have pursued with determination and doggedness have succeeded in producing work of quality. Many people ask, how is it that scientists in India cannot make a chance discovery which is great? Unfortunately, even to make a chance discovery, one has to be on the right path. We cannot make a great discovery by chance, if we are not already pursuing something important and significant.

Because we decide to compromise, many of us lose the confidence to pursue something difficult or of value to society. We become afraid of scrutiny and evaluation. Lack of confidence amongst senior scientists affects the attitudes of young people. The senior scientists have to lead the way by means of what we practise. We have to develop a better value system and improve communication amongst ourselves.

We cannot possibly forget that in this country we have had many great scientists of determination and courage who accomplished a great deal in science. We cannot think of better examples of men of science than Ramanujan, Raman and S. N. Bose. Raman was sure that he would win a Nobel Prize when he discovered the Raman Effect and, in fact, there is reason to believe that he was sure of it even much earlier. Raman published independent research papers when he was still an undergraduate student in Madras. S. N. Bose, shortly after his post-graduate studies, had the courage to send his research results to none other than Einstein for review. This example of courage of conviction is something that we have to emulate; it needed tremendous confidence to feel that the work he had done deserved the highest recognition. Einstein being what he was, recognised the genius of Bose rightway.

Much earlier to this, Ramanujan did something similar. Working as a clerk in a port trust, with no one to help and without a college education, Ramanujan felt that he had discovered something new working on "Orders of Infinity" and sent the result to Prof. Hardy at Cambridge. This led to a new era in Mathematics.

We have to do something to recognise talent at the right time, to nurture it and to protect people with talent. Man of talent are often subjected to considerable hardship and harassment. It appears as though that to get result that are worthwhile, we have to toil beyond the call of duty.

I cannot possibly brush aside the agony one goes through while doing science in India, especially experimental science in educational institutions. It is extremely difficult to carry out experiments which are worthwhile. It is much more difficult to do experiments that catch the imagination of the rest of the world. This requires enormous effort but it is essential if we experimental scientists have to make mark in the world. There is no other joy that I know of that is more overwhelming than the joy of a successful experiment planned by oneself. In this land of Karma, toil and sweat seem to be essential; even with toil and sweat, result are not assured, but without them nothing seems possible. We often have to struggle hard for little things and work against all odds, even without water and electricity. I realise that toiling hard in science may not be the best way to make money or earn a living, but I know no better way to live. One may ask whether I would recommend to young people to take up science as a profession. Yes, unhesitatingly I would. I believe that the thrill that I have experienced in doing science is worth sharing. The agony of doing science and the ecstasy when one accomplishes are both experiences that are worth cherishing.

Science has a simple faith which transcends utility. All men of science and probably men of learning have such a faith. The faith is that it is the priviledge of man to understand and that is his mission. Knowledge for the sake of understanding is the essence of our being. None can define its limits or set it's ultimate boundaries. ☐

ENVIRONMENTAL POLLUTION AND EFFECTS OF ENVIRONMENTAL POLLUTANTS AND TOXIC CHEMICALS ON HUMAN HEALTH, BEHAVIOUR AND MENTATION

D. BANERJEA*

ENVIRONMENTAL pollution is a state of the environment deleterious to life. The earth's surface (lithosphere and hydrosphere) and the atmosphere (troposphere and stratosphere) are of greatest concern in this respect. According to a recent report prepared by the Centre for Science and Environment, New Delhi, India is heading for ecological disaster; although with proper management of the environment this country has the capacity to feed three times the present population, effective concern is still lacking. The government is showing little will to control the use of dangerous pesticides and enforcing proper pollution control measures even in the

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large public sector projects. At present about 100,000 tons of pesticides are used annually in India and at least 70% of these are banned or their use severely restricted in the western countries of the world. A recent study report indicated that air and Damodar river water at Durgapur are heavily polluted. Huge quantities of fly ash (ca. 300 tons), ammonia, sulphur dioxide, silica dust, arsenic oxide, etc. are discharged into the atmosphere daily by the Durgapur Projects Limited (DPL) and other allied industries. The Durgapur Chemicals Limited (DCL) is presently releasing over 100 times the permissible amount of mercury into the Damondar river and as yet it has no effluent treatment arrangement. Study conducted by the CMDA in 1984 indicated that the total amount of pollutants (carbon monoxide, nitrogen oxides, hydrocarbons, sulphur dioxide and particulates) daily discharged into the atmosphere in the city of Calcutta is ca. 1300 tons (see Table 1).

TABLE 1 : Daily discharge (average) of different atmospheric pollutants at Calcutta (1984)

Species	Amount, Tons	% of Total
CO	450	34.5
SO_2	123	9.4
$NO + NO_2$	72	5.5
Hydrocarbons	100	7.7
Particulates	560	42.9

TABLE 2 : Classification of gaseous air pollutants

Type of compounds		Pollutants		Sources of the primary pollutants
		Primary	Secondary	
Sulphur compounds		H_2S, SO_2	SO_3, H_2SO_4	Combustion of sulphur containing fuels, bacterial de-composition of organic matter (produces mainly H_2S), volcanic activity, metallurgical operations, oil refining.
Nitrogen compounds		NH_3, NO	NO_2, HNO_3 O_3[a]	Chemical reaction between N_2 and O_2 in a high temperature combustion process produces NO. Some NO is also produced by bacterial action on organic matter and by natural electric discharge during lightening. NH_3 from bacterial decomposition of organic matter and also from synthetic ammonia plants of fertilizer industry.
Carbon compounds	(i)	C_1 - C_8 aliphatic hydrocarbons, and aromatic polycyclic hydrocarbons	Aldehydes, ketones, acids, peroxy compounds, O_3[a]	Combustion of carbonaceous fuels, petroleum refining, use of solvents, coal tar. Bacterial decay of organic matter produces CH_4.
	(ii)	CO, CO_2	None	Combustion of carbonaceous fuels, also natural photochemical oxidation of natural CH_4.
Halogen compounds	(i)	HF, HCI	None	Metallurgical operations, manufacturing processes.
	(ii)	Chlorofluorocarbons	Oxides of chlorine	Refrigerants, aerosol sprays, etc.

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[a] O_3 is produced in the trophosphere by photochemical processes involving O_2 with NO, organic compounds, etc. as catalysts and hence is present in "smog" (see page 73). Stratospheric O_3 is, however, beneficial and is produced photochemically by the action of UV radiation on O_2 (page 72)

The long term effects of such pollutants on human health and the ecosystem in general are much more serious than that of a disaster of the Bhopal type. Primitive living conditions add to the problem; cowdung smoke and wood smoke inhaled while cooking is considered as the world's worst pollution problem.

Most pollutants are chemical species which result primarily from human activity; chemistry also has a major role in the control and abatement of environmental pollution. In nature photochemical processes convert some primary pollutants to more harmful secondary pollutants (See Table 2).

Some of the pollutants have natural sources, but many are anthropogenic, while some belong to both categories(see Table 3).

TABLE 3: Global emission (1965) of NO_x and NH_3, in million tons

	Natural	Anthropogenic
$NO + NO_2$	450(a)	48(a)
NH_3	5350	3.8

(a) Expressed as NO_2

All the synthetic insecticides and pesticides are anthropogenic. CO is primarily anthropogenic, but small quantities are produced by the oxidation of natural CH_4 (from bacterial decomposition of organic matter) by photochemically generated OH radical:

$$O_2 \xrightarrow{h\nu} 2\,O;\; H_2O + O \longrightarrow 2\,OH$$

CO is then formed in a series of complex reactions between CH_4 and OH.

Table 4 gives an indication of the concentration levels of different pollutants in clean and polluted air.

Some essential constituents of the natural environment are deleterious under certain conditions such as concentration level, i.e. below a certain limit these are practically harmless. Stratospheric ozone O_3 (ca. 10 ppm) protects life on earth from the dangerous solar UV radiation ($\lambda \leq 2900$Å) by absorbing the same: $2\,O_3 \xrightarrow{h\nu} 3O_2$. But its presence in the lower troposphere is very deterimental to life. The concentration of O_3 in non-polluted tropospheric air is ≤ 0.05 ppm. In the stratosphere O_3 is generated from O_2 by a complex photochemical process initiated by solar UV radiation in the 2400-3000 Å wavelength region, and its concentration is maximum at an altitude of ca. 20 km from earth's surface.

TABLE 4 : Concentration of pollutants in air

Species	Concentration	
	Clean air	Polluted air
CO_2	300-330 ppm	350-750 ppm
CO	< 1 ppm	5 - 200 ppm
SO_2	0.001-0.01 ppm	0.02-2 ppm
NO_x	0.001-0.01 ppm	0.01-0.5 ppm
O_3	<0.05 ppm	>0.05-0.5 ppm
Hydrocarbons	1 ppm	1 - 20 ppm
Benzopyrene	<0.005 ppm	>0.005-0.05 ppm
Pb	0.002 ppm	≥0.008-0.04 ppm
Particulate matter	10-20 μg/m³	70-700 μg/m³

$$O_2 \xrightarrow{h\nu} 2\,O,$$
$$O_2 + O \longrightarrow O_3 + \text{energy}$$

The net process $3\,O_2 \rightarrow 2\,O_3$ is very endothermic to the extent of 142 kJ per mole of O_3 produced. O_3 itself absorbs UV radiation of λ = 2000-3600 Å which leads to a reversal of the above process leading to decomposition of ozone, and thus a steady state concentration is established. The net result of all these is the absorption and conversion to heat of considerable solar UV radiation that would otherwise strike the earth's surface. Significant depletion of stratoshperic ozone is of grave concern as this could have serious effects such as increased surface temperature of earth, high incidence of skin cancer due to effect of UV radiation, etc. Ozone is destroyed by chemical reactions initiated by oxides of nitrogen and chlorofluoro carbons such as freons widely used as foam blowing agents, aerosol propellants and refrigerants; some NO is produced in all high temperature combustion processes and is therefore present in the exhaust gases of rockets and engines of jet planes. The supersonic jet planes flying at high altitude discharge significant amounts of NO in the upper atmosphere. NO acts as a catalyst to destroy O_3:

$$NO + O_3 \longrightarrow NO_2 + O_2$$
$$NO_2 \xrightarrow{h\nu} NO + O$$

Photochemical reaction by sun light

$$NO_2 + O \longrightarrow NO + O_2$$
$$NO_2 + O_3 \longrightarrow NO_3 + O_2$$
$$NO_3 \xrightarrow{h\nu} NO + O_2$$

Similarly, chlorofluorocarbons such as freons also destroy O_3 catalytically due to photochemically generated Cl atom:

$$CFCl_3 \xrightarrow{h\nu} CFCl_2 + Cl$$
$$CF_2Cl_2 \xrightarrow{h\nu} CF_2Cl + Cl$$
$$O_3 + Cl \longrightarrow O_2 + ClO$$
$$O_2 \xrightarrow{h\nu} 2\,O$$
$$ClO + O \longrightarrow Cl + O_2$$

It is estimated that the rate of chlorofluorocarbon release in the atmosphere prevailing in 1977 if remained uncontrolled could reduce the O_3 layer significantly by the year 2000.

Atmospheric carbon dioxide (ca. 300 ppm in clean air) controls the terrestrial temperature by its greenhouse effect. The sun is like a "black body" at a temperature of ca. 6000°C and radiation from the sun covers a wavelength range of 2,000 - 20,000 Å with ca. 40% being in the visible (4000 - 7000 Å) region. Only about 50% of solar radiation (mostly visible and infrared) penetrates through the atmosphere to reach the earth's surface. Earth reradiates the absorved energy, but being at a much lower temperature the radiation from the earth's surface is mostly in the infrared region with a peak around(1.0-1.5) x10^5Å wavelength. This is effectively absorbed by the water vapour and particularly by the CO_2 present in air and the energy so absorbed is radiated back to earth. This is the well-known greenhouse effect by which earth's surface temperature is kept controlled. It is estimated that in the absence of CO_2 and water vapour in the atmosphere there would have been a variation of earth's surface temperature from ca. 80°C in day time to ca. -140°C at night. A higher concentration of carbon dioxide in the air can be beneficial to many plants. Experiments conducted with tomatoes, lettuce, etc. grown in an artificial atmosphere having 2000 ppm CO_2 showed increased yield, both in size and weight (over 115% increase in dry weight) and better quality (more vitamins, sugars and other nutrients). But a high concentration of CO_2 in air will cause an adverse rise of atmospheric temperature and that of the earth's surface which would upset ecological balance. In the 100 year period between 1880 to 1980 there was an increase of 45 ppm in the atmospheric CO_2 which caused an average increase of global temperature by ca. 0.4°C.

Oxides of nitrogen (NO_x) and oxides of sulphur (SO_x) and particulates are responsible for the two well-known types of smog. The chemical reactions involved in the two types of smog formation are outlined below:

$$N_2 + O_2 \xrightarrow[\text{combustion process}]{\text{High temperature}} 2\,NO$$

Some NO is also formed by bacterial action on nitrogen compounds present in soil.

$$2NO + O_2 \longrightarrow 2NO_2$$
$$NO_2 \xrightarrow{h\nu} NO + O$$
$$O + O_2 + M \longrightarrow O_3 + M^*$$

M is a third body which takes up the energy (107 kJ mol^{-1}) liberated in the reaction of O_2 with O atom forming O_3; the M is thereby raised to an excited (energized) state denoted by M^*.

$$O_3 \xrightarrow{h\nu} O_2 + O + Q$$

Q is the energy which is liberated in the process.

$$O_3 + NO \longrightarrow NO_2 + O_2;\ NO_2 \xrightarrow{h\nu} NO + O$$
$$RCH_3 + O \longrightarrow \dot{R}CO$$

(Hydrocarbon)

$$RCO + O_2 \longrightarrow RCO_3$$

$$RCO_3 + RCH_3 - \longrightarrow RCHO \text{ and } R_2CO$$

(Aldehydes) (Ketones)

$$RCO_3 + NO \longrightarrow RCO_2 + NO_2$$

$$RCO_3 + O_2 \longrightarrow RCO_2 + O_3$$

$$O_2 \xrightarrow{h\nu} 2\,O$$

$$H_2O + O \longrightarrow 2\,OH$$

$$RCO_2 + OH \longrightarrow RCO_3H$$

(Peroxy acid)

$$RCO_3 + NO_2 \longrightarrow RCO_3NO_2$$

(Peroxyacyl nitrate, PAN)

The mixture of NO, NO_2, aldehydes (particularly acrolein, $CH_2{=}CHCHO$) ketones, peroxy compounds including PAN causes the brownish coloured irritating and injurious NO_x type smog.

SO_2 produced in burning of coal (which always contains sulphur) is responsible for SO_x type smog:

$$O_2 \xrightarrow{h\nu} 2\,O$$

Dissociation of a O_2 molecule requires high energy (498 kJ mol^{-1}) and this can be provided by UV solar radiation of $\lambda < 2400$ Å.

$$SO_2 + O \longrightarrow SO_3$$

$$2SO_2 + O_2 \xrightarrow[\text{as catalyst + sunlight}]{\text{Particulates}} 2SO_3$$

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

This H_2SO_4 is carried by suspended particles in the air forming a mist which together with free SO_2 forms the SO_x type smog. Both SO_2 and H_2SO_4 are injurious. Smog (SO_x type) caused death of over 4000 people in London in 1952 and many more became seriously ill with diseases of the lungs and the respiratory tract. NO_x and SO_x are also responsible for 'acid rain'. Normal pH of rain water is ca. 5.6. In many parts of the world, particularly in highly industrialized countries, acid rain (pH $\leq$ 4), is very common due to HNO_3 and H_2SO_4 in the rain water. These acids are produced from SO_2 and NO which, as stated earlier, have their origin in combustion processes. How SO_2 is converted to SO_3 and then H_2SO_4 has been discussed above. NO is transformed to HNO_3 as follows:

$$2NO + O_2 \longrightarrow 2NO_2$$

$$NO_2 + OH \longrightarrow HNO_3$$

Photochemical generation of OH has been discussed earlier. Apart from its damaging effect on matallic and stone structures, acid rain is the cause of low pH of the water of many lakes. Acidity of natural waters causes ready dissolution of harmful mercury, lead and aluminium into water causing injury to aquatic life particularly fish; the low pH (even ca. 2 in some cases), is also detrimental for fish to survive. Many natural lakes are now devoid of fish due to such low pH (acidity) of the lake waters. Carbon monoxide, CO, is another air pollutant of grave concern the effects of which are discussed later.

Some pollutants are essential at very low concentrations, e.g. chloride, fluoride, iodide, zinc and many other essential trace metals (copper, chromium, vanadium, etc.). 1ppm of fluoride in drinking water reduces considerably the incidence of dental caries. Iodized salt is used to reduce incidence of goiter. Foods deficiant in Zn, Cr, etc. lead to deficiencies of these essential trace metals in man which is deleterious to health and such cases will be referred to later. Synthetic inorganic fertilizers have bad effects too. The phosphates make the essential trace metals (Mn, Fe, Cu, Zn, Mo) less readily taken in from the soil by plants due to their conversion to very isoluble phosphates. Both nitrates and phosphates leached out from fields into rivers and lakes lead to 'algal bloom' and may ultimately lead to eutrophication.

Many of the well-known insecticides and pesticides are mutagenic poisons and find their way into the body of higher animals and man through the usual food chain. One such compound is DDT which was hailed as a miracle in 1940's for controlling malaria, typhus and sleeping sickness. By 1950's many insects had developed resistance to DDT and being not biodegradable DDT was found concentrated in living beings through food chain. In lakes and ponds where DDT was sprayed, small amounts of DDT were stored in the body fat of micro organisms and from there in larger organism and fish, and then into the body fat of larger animals, and alarming concentrations of DDT have been detected in many cases. Predatory birds and animals at the top of the food chain have large DDT concentration and this high DDT level contributed to the decline of such species as hawks, eagles, falcons and brown pelicanes. Hence, DDT and other chlorinated hydrocarbons have been banned from wide spread use in all the developed countries. DDT is also stored in human body fat and has been detected in human breast milk.

A recent (1984) study conducted in different parts of India has indicated that 50% of vegetable samples collected from markets are heavily contaminated with pesticides. Potatoes from Maharashtra contained 4.2 ppm DDT and 1.4ppm dieldrin against tolerance limits of 1.0 and 0.1 ppm respectively. Pesticides were found much higher than tolerance limits allowed by W.H.O. and F.A.O. in samples of fruits, vegetables and milk from Bombay.

Another study conducted by IIT, Kanpur in 1984 indicated that an average Indian's diet contains ca. 0.27 mg DDT. Substantial amounts of pesticides have also been detected in samples of milk, vegetables, oils and eggs collected from Delhi, Pune, Lucknow and Bangalore. F.A.O. in world survey showed that more than 364 species have become resistant to pesticide chemicals.

DDT had not been shown to be toxic to man in doses upto those received by factory workers involved in its manufacture but its structure is such that it is not readily broken down(metabolized) by animals and fish. The biological half-life of DDT is 8 years. Hence, if DDT enters into animal body at a steady rate the DDT builds upto a high level. For many animals this is not a problem but for same species of birds of prey such as eagles and ospreys, which feed on animals and fish, the consequences are dissatrous. The DDT in fish enters the bird's body where it concentrates. The bird attempts to metabolize the large amount of DDT by an alteration of normal metabolism pattern which involves the use of agents which regulate the calcium metabolism of the bird as is vital to enable the bird to lay eggs with strong shells. When these agents are directed to their new use to tackle the excessive concentration of DDT the calcium metabolism is hampered seriously and the birds lay eggs with fragile shells and as a result their survival rate decreases very drastically. Infact, this has led to almost complete extinction of eagles and ospreys in various regions of the globe. Organic chloro compounds such as dieldrin and heptachlor are similar resistant pesticides. Chlordan though similar in structure to heptachlor (see Fig.1) is bio-degradable and research is on to make many such bio-degradable insecticides and pesticides.

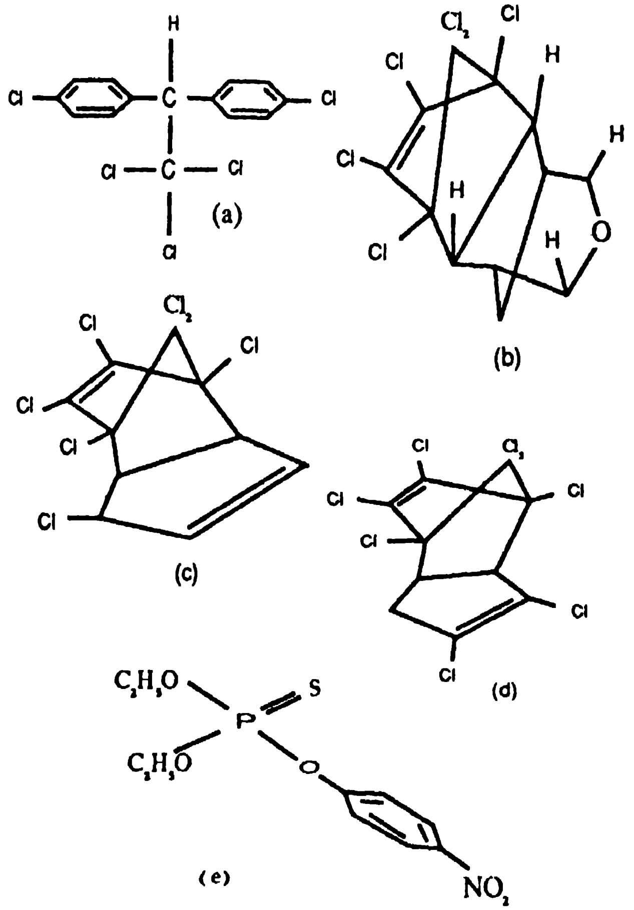
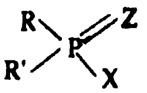


Fig. 1. (a) DDT; (b) Dieldrin; (c) Heptachlor; (d) Chlordan; (e) Parathion

There are many insecticides which are more toxic to man than DDT. These include some compounds of arsenic and phosphorus. A variety of phosphorus derivatives like



are in wide use, where Z =O, S, R, R' = C_2H_5, C_2H_5O, C_2H_5S, NH_2, etc. and X is a group which can be easily split from the phosphorus atom.

Parathion (see Fig.1) belongs to this group and is effective against a large number of insects but is also very poisonous to human beings. One of the most important properties of such compounds is that these are readily hydrolyzed to less toxic substances which are not residual poisons. These are therefore better than the long lived DDT and such other insecticides.

Complete banning of the use of insecticides and pesticides is no solution since agricultural products could drop precipitously if this is done. An enlarged human population requires that crops be protected against the ever present threat of destruction by insects. Furthermore, the use of insecticides is essential if we are to control malaria, plague and such other diseases. It must be recognised that a single insect species, the tsetse fly, alone has retarded the development of over 4,000,000 sq. miles of Africa by means of the diseases which it transmits to men and cattle. A refusal to use insecticides means that man must tolerate malaria, plague, sleeping sickness, etc. and consumption of a large part of his food supply by insects.

Burning of coal, wood and fuel oil in crude burners causes discharge of significant quantities of polycyclic hydrocarbons like dibenzanthracene, methylcholanthrene and particularly benzo(α) pyrene (see Fig. 2) into the atmosphere; these are carcenogenic. Many of the food colouring agents such as metanil yellow and tartrazin (see Fig. 2) used till recently (now banned in the West but are still in sue in India and other developing countries) are also carcenogenic. Use of mercury preparations like mercurochrome (see Fig. 2) (an antiseptic) is banned in the West and is still in use in India.

Our greatest concern for pollution is its effect on human health which may be transmitted through generations. The pollutants are primarily metabolic and neurotoxic poisons. For many of these such as lead, significant effect is observed even at 1/1000 of the threshold lethal dose (LD$_1$).

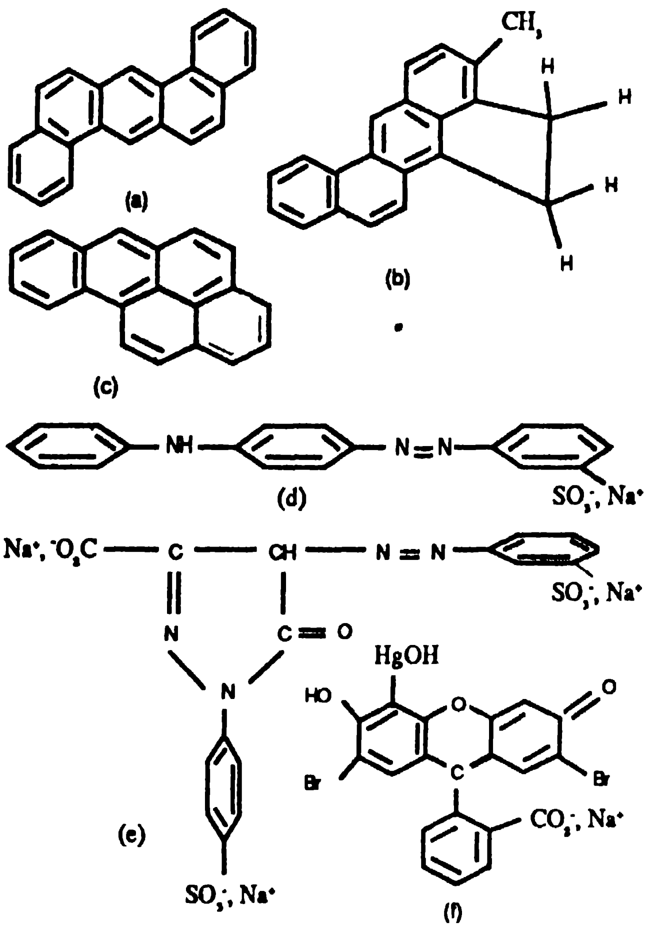


Fig. 2: (a) Dibenzanthracene (b) Methyl cholanthrene
(c) Benzo(α)pyrene (d) Metanil yellow
(e) Tartrazin (f) Mercurochrome

Behaviour is the output from brain function due to complex chemical processes initiated by input from physical senses. Certain chemicals effect functioning of brain and the central nervous system (CNS) causing change in behaviour pattern. Chemicals of concern are heavy metals (Hg, Cd, Pb, etc.), ethanol, nicotine, and drugs like tranqullizers, sedatives, oral contraceptives (birth control pills), etc.; exposure to these is voluntary in many cases and involuntary in case of others.

Mercury: This is extremely harmful, even a concentration of 0.03 ppm in drinking water is not permissible. Mercury enters natural waters through industrial discharge where by bacterial action it is converted into the stable and soluble methyl-mercury, Hg(Ch$_3$)$^+$, which is taken up by fish and through food chain enters higher animals and man. Most of the fish today have a mercury concentration of 0.02-0.2 ppm which is considered 'normal'; in polluted water it may be >1 ppm. Consumption of such fish is hazardous (cf. minamata disease, Japan). Mercury deactivates sulphur containing enzymes, affects brain cells and the central nervous system. Symptoms of mercury poisoning are physical and emotional disturbance, self-consciousness, timidity, embarrassment with insufficient reason, anxiety, indecision, lack of concentration, depression or despondency, resentment of criticism, irritability or excitability—a complete change of personality (cf. The Mad Hatter in "Alice in Wonderland" story).

Lead : Lead paints in common use was the principal source of lead (Pb) poisoning earlier, but presently lead tetraethyl Pb (Et)$_4$, used as an anti-knock in gasoline is the principal source. There is good correlation between blood Pb levels and exposure to Pb in ambient air. Safe limit of lead in air is ~10 µg/m^3. In big cities during peak hours (high traffic) upto 50 µg/m^3 or even more has been detected. The lead compounds carried into the air settle in fields and through food and drinks enter human body. Many food stuff have lead content of 100-300 µg/kg. In the USA daily intake of lead in man is estimated ca. 1.7 mg; excretory mechanism in a healthy man can tackle upto ca. 2 mg/day. Excess accumulates in the body and has a cumulative effect. Lead deactivates/destroys sulphur containing proteins and enzymes, causes damage to DNA, RNA, brain and CNS functions. Lead also inhibits several steps in the formation of haemoglobin. Use of leaded gasoline is now restricted and many other means of improving fuel quality have been proposed in the developed countries. Symptoms of lead poisoning are restlessness, talkativeness, illusions, mania, over-anxiety, aggression, sucidial tendencies and symptoms of schizophrenia (cf. drunkards and lunatics). Like mercury metallic lead is also absorbed through the skin and causes poisoning. School children (in UK and USA) having higher lead content in teeth have significantly lower IQ. Cadmium also has effect similar to those of lead and both seriously affect release of neurotransmitters which are vital for transmission of nerve impulses. Enzymic conversion of ATP to ADP releasing energy needed for life process is significantly inhibited by lead. Of all environmental neurotoxins lead is most serious and widespread in its subtle and insidious impact on man. Even at low levels it causes increased tension, anger, depression and impaired memory.

Nicotine : Main source is tabacco smoke. For nicotine lethal dose is fairly low (LD_{100} = 4.3 mg/kg body weight). Even at lower concentration it affects brain function. Smoking produces adverse effect on learning and memory; hostility and aggressiveness which are decreased initially are increased after cessation of smoking. Smokers also inhale ca. 200-400 ppm carbon monoxide (CO) with every puff and in a heavy smoker 5-15% of haemoglobin (Hb) is converted into carboxy haemoglobin, Hb.CO. Oxygen transportation is thus hampered affecting brain and nervous function. The binding of CO to Hb is ca. 500 times stronger than that of O_2. Air contains ca. 0.1 ppm CO; during rush hour traffic in big cities this increases to even ca. 100 ppm due to incomplete combusation of fuels forming CO. For 8 hr. breathing 10 ppm CO is the maximum limit, 4 hr. breathing in air having 300 ppm of CO causes unconsciousness due to 35% Hb being converted into Hb. CO, while 4 hr. breathing in air having 750 ppm CO causes death due to 60% Hb being converted into Hb. CO. In all the developed countries the automobile engines are suitably designed such that with a proper control of fuel: air ratio the generation of CO is reduced, as also of unburnt hydrocarbons and carbon particles. Their exhaust systems are also fitted with suitable catalytic converters which eliminate unburnt hydrocarbons by their oxidation to CO_2 + H_2O, CO by its oxidation to CO_2 and NO by its reduction to N_2 . Despite generation of CO in combustion processes and photochemical oxidation of natural CH_4 (*loc. cit.*) (the ambient concentration of CH_4 in the atmosphere is 1.5 ppm) its concentration is maintained at a steady value mainly due to its oxidation to CO_2 by photochemically produced OH radical:

$$CO + OH \longrightarrow CO_2 + H; \; H + OH^- \longrightarrow H_2O$$

Because of appreciable solubility of CO in water oceans have large quantities of dissolved CO and this CO in solution also gets slowly oxidized to CO_2.

While talking about pollutants it is also worthwhile considering the bad effects on human health of various drugs to which exposure may be voluntary or involuntary (i.e. when these are used as medicines of necessity). Tranquillizers, sedatives, anti-depressants and neuroleptic agents are mostly medically prescribed. All these produce benevolvent short-term alterations in behaviour through chemical effects on the central nervous system. However, many of these pose a hazard to the foetus if taken in pregnancy. Prolonged use of some tranquillizers can lead to addiction with serious behavioural symptoms on withdrawal. Some anti-depressants can produce adverse effects on the moral sense— lack of awareness of emotions of others, self-centered behaviour, etc.

Teratogens are substances which cause physical/physiological deformities in the developing embroyo and foetus. Thalidomide is the best know example. Others are X-rays, sulfonamides, excess vitaminA, mercury, lead, cadmium, ethanol (alcohol), deficiencies of B vitamins and of zinc and chromium; at least 30 such different agents are now recognised. For many teratogens low level exposure during pregnancy may give birth to a baby which appears normal but serious defects in intelligence, personality and behavioural control appear in later life.

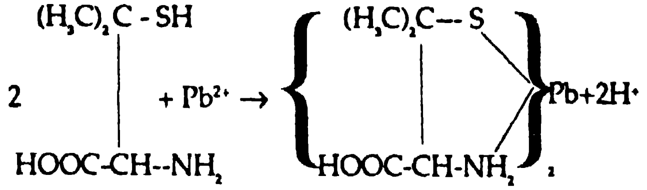
Ethanol is a behavioural teratogen and reference to its foetotoxicity is found in the Holy Bible. But modern medical profession recognised this in the mid 1970-s only. Its effect on the neonate can be mild (e.g. low birth weight) to severe (e.g. heart damage, death) and certainly include mental defects and disorders of behavioural control in later life. As little as one alcoholic drink every three days during pregnancy can increase the risk of miscarriage. Effects are enhanced by smoking, by lead, and by zinc deficiency. Ethanol also increases urinary excretion of zinc. Mental disorders due to severe alcoholism can be successfully abated by administration of zinc sulphate with food. Cigarette smoking during pregnancy is reported to correlate significantly with educational under-achievement as also behavioural and psychological deficiencies in the offspring. Anaesthetics, tranquillizers, anti-depressants, sedatives and several other drugs must be used with caution during pregnancy to avoid injury to the developing foetus and physical and mental disorders in the offspring.

Exposure to teratogens even before conception has adverse effects on offspring due to malformation of sperms, and/or chromosomal abnormalities and/or abnormalities of seminal fluid. There is known correlation between male sub-fertility and low semen zinc. The femal ovum is, however, better protected from environmental toxins, but femal sexual behaviour is affected adversely. Disorders may therefore result prior to conception from action of behavioural genotoxins on sperm, between conception and birth by the action of behavioural teratogens and after birth by exposure to behavioural toxins.

Zinc is a constituent of may enzymes involved in the metabolism of DNA and RNA. About 20 zinc dependent DNA and RNA polymerases are known and zinc is also required to stabilise the structure of these genetic molecules. Hence nutritional zinc deficiency, now quite common (in UK and other countries) and zinc antagonists such as cadmium and lead, can disturb genetic expression at the most fundamental molecular level. When this involves those genes which control development of the physical brain, and remains uncorrected by genetic repair process, it can be expected to hinder the expression of a future individual's true mental potential. These account for the genotoxicity of lead and adverse genetic effects of zinc deficiency. Some types of schizophrenia appear to be associated with raised levels of copper in conjunction with low levels of zinc and/or manganese. Correction of these imbalances has been reported to bring clinical improvement.

Calcium, magnesium and manganese are of great neurochemical importance. Calcium has vital role in nerve function including neurotransmitter release. Symptoms of hypocalcemia are identical with those of anxiety neurosis. Antagonism between lead and calcium is one of the most notable features of lead toxicology and appears to be involved in some of the neuro behavioural effects of lead. Antipsychosis activity of lithium depends partly on its ability to stimulate calcium metabolism and reduce urinary loss of calcium. Lithium salts proved very successful in abating the violent propensities of criminals without any undesirable side-effects on behaviour and intelligence, but lead works in the opposite direction. Evidences have been adduced that environmental neurotoxins like lead are a significant factor in promoting criminal behaviour.

Hyperactivity is a neurochemical dysfunction which results from various causes including effects of some chemicals such as tartrazine (food colourant), benzoate (preservative), pre-natal alcoholism in the mother, and lead. Hyperactivity can be effectively abated by penicillamin, a chelating agent which promotes urinary excretion of stored lead:



Australian and Canadian workers have reported markedly elevated lead burdens in children who are delinquent and anti-social, and also in violent criminals respectively. Apart from lead, zinc, cadmium and chromium also appear worthy of such studies. Reports from USA indicate that anti-social behaviour among prison inmates can be significantly abated by careful dietary control to prevent deficiencies in micro-nutrients like zinc, copper, chromium, vanadium, etc.

Hypoglycaemia is common among violent offenders in USA; their behavioural control improves by correction of low chromium level by administration of ca. 200 µg chromium per day. Maniac patients have high vanadium level, control of vanadium metabolism improves the condition. *Anorexia Nervosa* is now known to be due to severe zinc deficiency and is corrected by administration of zinc sulphate (60 - 660 mg/day). Most of our inability to treat and cure mental and behavioural diseases is due to our failure to recognise so far the chemical imbalances which are primarily responsible for such disorders. Much more systematic studies are needed in this area.

Notes and news

On Studies of Comet Halley

The Solar system is made up of nine large planets and a host of small bodies known as satellites, asteriods, comets and meteors of every size and shape.

Small bodies played an important part in the evolution of this Solar system. Close on 4 billion-years ago they were much more numerous than now. Some of them collided, forming embryonic planets which over the next 100 million years captured the bulk of primary matter and became large planets.

What small bodies remained are the relics of a violent and mysterious phase in the life of the Solar system —its formation. The study of these small bodies, particularly meteors which are unique specimens of cosmic matter, makes an important part of planetary cosmogony.

Cosmonautics and space technology offer a unique chance for studying small bodies directly. A major step in this direction was made when man launched five inter-planetary unmanned probes (two Soviet Vegas, West European Giotto, and Japanese Suisei and Sakigake) to study Halley's comet. The Japanese probes that passed a great distance from the comet could survey only the outermost part of the coma and the tail. The principal task of the Vegas and Giotto probes was to study the nucleous.

Vegas began photographing the comet from a distance of 14 million kilometres. On the fly-by leg of the journey they filmed the comet from the opposite sides. Interpretation of the photo materials was far from easy: the picture was obscured by dust jets spinning away from the comet. Nonetheless, the analysts who were able to specify the size the shape of the nucleus, its general structure and reflection ability, established that the nucleus is an irregular monolithic body with the dimensions of 8 x 8 16 kilometres.

The period of rotation with its axis located within a cone whose radius at the opening is plus-minus 45 degrees from the normal to the orbit's plane, is 53 plus-minus three hours. The rotation is clockwise, as seen from the northern pole of the ecliptic (i.e., coincident with the direction of orbital movement.). The reflection ability is very low —about four per cent. The nucleus of Hally's comet is one of the blackest bodies in the Solar system.

Dust ejection occurs only on the daylight side of the nucleus. In some areas, ejections take the shape of jets spinning away from the nucleus. There is a one-kilometer-thick shell around the comet body, inside which outflowing gas accelerates dust particles to velocities of up to several hundred meters per second.

Photographs taken by Vegas show curiously-shaped features resembling circular craters. Information procured by Giotto confirms the existence of ring-shaped craters in the vicinity of the terminator where the dust layer is the lowest and illumination the brightest.

On the basis of information obtained by Vega One's infrared spectrometers specialists established the temperature on the surface at 380 plus-minus 30 degree Kelvin—almost twice the expected temperature. The high temperature is explained by the presence of a black layer of porous snow, a phenomenon not unlike the heaps of snow in urban streets in spring. Computations show that the layer is apparently very high—a few millimeters and even less. The existence of this layer does not surprise researchers who are well aware that the comet's ice is stuffed with the particles of refractory materials which stick to the surface as frozen gases evaporate.

The above temperature value of 380 degrees Kelvin is associated with the hottest sector of the comet—in the equator zone on the daytime side of the comet. It is approximately one degree removed from the mid-day point on account of thermal inertia in the surface layer. The night-time side of the comet is much colder, with the temperature not higher than 180 to 200 degrees Kelvin.

Anlaysis of ejected gas and dust composition yielded very interesting information about the comet's matter which is largely carbon dioxide and water steam mixed in ratio of 1:5. Apparently they make part of the nucleus in the form of the clathrate (a type of solid molecular compound in which one component is trapped in cavities of cage-like crystals of another component).

Very interesting information about cosmic particles was yielded by dust-shock mass-spectrometers installed aboard Vega probes. Having analysed about 2,000 dust particles they established that some are made up largely of light elements and others of carbon and metals.

Their spectrums enabled Lev Mukhin, Doctor of Physics and Mathematics, of the Institute of Space Research of the USSR Academy of Sciences, to argue that the carbon-silicon ratio in carbon-rich particles is much higher than in a meteorite of any type and that nitrogen is always present in particles with a high carbon-silicon ratio. This is possible only if carbon and nitrogen are present in organic molecules. On that ground he insists that the comet's nucleus contains complex organic molecules.

It has been calculated that in the vicinity of perigee the comet rapidly loses matter at a rate of about 40 tons per second. A simple arithmetic with the mass of the comet and the rate with which it loses matter gives us an approximate date of birth of the comet. Halley's comet is about 20,000 years old. It could be older assuming that the activity of the comet diminishes with every Sun pass.

The models of Halley's comet developed prior to the latest space venture, meaning the flight of five robots to the comet, showed it as a cluster of loose boulders, or an irregular monolithic body made up of frozen volatile substances mixed with meteorite materials, or a body made up of refractory silicates and metals inside a shell of frozen gases, or a snow mountain made up of snow flakes with a complex inter-stellar structure.

In a dispute over the comet's nucleus and, therefore, the origin of comets, scientists have split into two groups, each advancing its own hypothesis.

According to the first version, comet nuclei were born inside a gas-and-dust nebula that surrounded the young sun 4.5 billion years ago just before the planet formation process began. They emerged at a distance of 10 to 30 astronomical units (a unit of length used in astronomy equal to the mean radius of the earth's orbit), in the zone where temperature was relatively low, and were scattered by the gravitational fields of the just formed giant planets. Some of them were thrown into the internal regions of the Solar system and rapidly disintegrated. Others "retreated" to the outskirts of the system and formed the so-called Oort's belt.

According to the second hypothesis comet nuclei were born inside the dense clouds of inter-stellar matter. Its advocates insist that the clouds, rather than the primary protoplanetary nebula, supply small bodies for Oort's belt.

Only direct studies of the isotope composition of cosmic matter could solve this dispute. The only means to do so is to obtain a sample of this matter. But the speed of Halley's comet retrograde motion was too high for the probes which could not approach its nucleus. Meanwhile, the majority of comets are characterised by direct motion. Some of them are available for direct contact. An expedition of that category could be organised by the end of this or the beginning of the next century. Scientists are considering such a possibility. ☐

Vasily Moroz

ISPP—International Conference of the Plant Physiologists of the SAARC Countries

A four-day international conference organised jointly by Indian Society for Plant Physiology and Gorakhpur University, Gorakhpur was held in the Department of Botany of the

University during December 20-23,1987. The theme of the conference was "On the role of plant physiology and biotechnology in crop productivity". The deliberations were categorised in four parts:

(I) Invited lectures, (II) Paper presentations, (III) Young scientists' paper presentations and (IV) Poster presentations.

Part-II included five technical sessions, namely (i) Carbon metabolism, (ii) Nitrogen metabolism, (iii) Stress physiology, (iv) Physiology of Plant growth, development and yield and (v) Mineral nutrition.

The conference was inaugurated by V. Puri, Professor Emeritus, Meerut University, Meerut. In all, 100 research papers, including poster presentations, were submitted by delegates from SAARC countries representing various educational and research institutions.

In his presidential address, S. N. Mathur of Botany Department, Gorakhpur University, Gorakhpur mentioned the aim of instituting the South-Asian Association for Regional Cooperation (SAARC) and pointed out that the people of the region constituting one-fifth of the world's total population are the poorest and suffer from many natural calamities such as floods, drought, etc. year after year. Mathur, therefore, emphasised that the plant physiologists of these countries should work hand in hand to solve problems of agriculture related to the crop productivity with a view to ameliorating the living conditions and standard of the people. To attain the goal, an association of plant physiologists of SAARC countries was formed during the conference. Mathur was elected its first president. Two vice-presidents were Q. A. Fatah of Bangladesh and D. N. Bajracharya of Nepal, while D. N. Tyagi of (BHU) India was elected to be its general secretary. The executive committee included one representative from each of the SAARC countries.

The Society for Plant Physiology also announced the award of medals to various scientists for their outstanding contributions in the field of plant physiology. The J. J. Chinoy medal for 1983 was awarded to B. K. Gaur of Bombay, for 1984 to K. S. Murty of Cuttack and for 1985 to M. M. R. K. Afridi of Aligarh and S. N. Mathur of Gorakhpur. The AAAS medal for 1984 was given away to Venkateshrlu of Hyderabad and for 1985 to R. M. Pandey of Bangalore. The various medals for 1986 and 1987 were also declared by the Society. The J. J. Chinoy medal for 1986 was conferred upon O. K. Garg of Varanasi and the AAAS medal for 1987, upon R. S. Dwivedi of Lucknow. On the other hand, the AAAS medal for junior scientists for 1987 was awarded to Rajendra Sharma of Ludhiana. The recipients of the R. D. Asana medal for plant physiologists below 35 years of age were K. P. Singh of Himachal Pradesh for 1986 and Shamim Akhtar Ansari of Aligarh for 1987.

Among invited lectures, P. Tauro of Department of Microbiology, HAU, Hissar reviewed the status of knowledge pertaining to biological nitrogen fixation in tropical and subtropical countries. He pointed out that a large area of Indian arable land does not contain adequate population of effective rhizobial strains which consequently diminishes soil fertility. Therefore, Tauro advocated to isolate and multiply effective rhizobial strains from natural population and utilise them for seed inoculum. According to him, inoculation with effective rhizobia may reduce our dependence upon costly synthetic nitrogenous fertilisers. Randhir Singh of Department of Chemistry and Biochemistry of the same university elucidated the transport of symbiotically fixed dinitrogen in legume-rhizobium system. The molecular nitrogen, after being converted into ammonia by nitrogenase present in the bacteroids of legume root nodules, is excreted into host-cell cytoplasm where ammonia is incorporated into some organic compounds. They act as a vehicle to transport the fixed nitrogen and are of two types, i.e. amides and ureides. The former is a source of transport in temperate legumes and the latter in tropical legumes. The mode of synthesis of amides and ureides has been understood to a large extent and found to be highly regulatory at cellular and sub-cellular level. Singh also discussed the metabolism of transported amide and ureide nitrogen in the plant. He noted that 75-90% of the imported amide or ureide nitrogen is rapidly metabolised.

Two merit certificates earmarked to encourage excellence in oral presentation by young plant physiologists below 30 years of age were awarded to Shamim Akhtar Ansari of Aligarh Muslim University, Aligarh and Malvika Mathur of Gorakhpur University, Gorakhpur in the concluding annual plenary and general body meeting. The Society also decided to constitute a five-member committee to draw the norms for electing its fellows. Lastly, it was announced that the 1988 Annual Conference of the Society will be sponsored by the C. S. Azad University of Agriculture and Technology, Kanpur. ☐

Shamim A. Ansari, Moinuddin
and Nafees A. Khan

Catch and kill insect by power sprayer suction trap

A mechanical device for trapping the insects has been recently developed in a collaborative effort of the Departments of Entomology and Farm Machinery, Tamil Nadu Agricultural University, Coimbatore. The device is nothing but a knapsack power sprayer operated suction trap. Two spray booms are connected by means of a 'T' joint. The booms are connected to the blower inlet by suitable provisions. To facilitate this, the clearance between the blower and power sprayer frame is increased. A transparent container is fitted to the open and of the 'T' joint. An inclined slit is made in the 'T' joint and a suitable sieve is placed in the slit so that the air from the blower passes through the sieve. Method of using the trap is similar as using the power sprayer except that instead of spraying insecticides, the operator will suckin the insects through the twin boom assembly. The sucked insects will be trapped in the container provided.

Field tests conducted with the power sprayer operated insect trap in paddy, sorghum, cotton and sunflower crops proved effective for trapping insects like hoppers, midges, eahead bugs, white flies and ash weevils. Since majority of the insects trapped were found to be alive, there is scope for using this gadget as a large scale sampling device apart from insect control. As the power sprayers are easily available in the farm, the power sprayer trap will be highly useful for the control of the above mentioned dreadful insects especially when there is a "severe outbreak".

This machine will be of great use for the Public Health Workers in controlling adult mosquitoes and flies. The attachment is simple and can be easily fixed on to any power sprayer. ☐

S.Mohan and A. Tajuddin

Letters to the editor

Studies on the relationship between phenological events and energy units in wheat genotypes

Relationship between the seasonal events of plants development (phenology) and climate are complex[1]. For obtaining desired levels of production, it is essential to know the limitations and potentialities associated with major crop varieties under stresses of weather and other constraints. Keeping this in view, the present investigation was planned to study the time course of phenological development in relation to energy units of selected wheat cultivars to establish time lag thereof.

The experiment was conducted in a randomized-block design, replicated tetra with plot size 2 m x 9 m. The sowing of wheat cultivars (WL 1562, WL 711, WG 357 and KSML 3) was done in the first week of November. The phenological observations were recorded from the preselected/tagged uniform four plants from each replication. The frequency of observations varied from one to three days, depending upon the rate of development of particular event of the crop. The data was analysed statistically. ACCDEG accounts for cummulative heat units for day (T_{DAY}) and night time (T_{NYT}) temperatures, calculated according to Baker *et al.*[2]

Table 1 shows that for the emergence of crown root, required at least 300 and 327 ACCDEG units in cultivars WL 1562 and WL 711 respectively and this requirement was met by increase in number of days. Cultivar WL 1562 took less number of days and heat units for attaining the tillering, initiation of joining and flag-leaf stages, while cv. KSML-3 to attain the flag-leaf stage and boot stages required longer duration (more number of days) and more heat units and it did not exhibit significant difference than that of cv.WG 357. The data also revealed that cv. WL 711 required significantly lesser number of days than cv. KSML 3 to reach 50% boot stage. The cultivar KSML-3 required the

TABLE 1 : Number of days and heat units required for the completion of different phenological events in wheat cultivars

Phenological events	No. of days after sowing cultivars[*]				C.D.	Energy units (ACCDEG) cultivars[*]				C.D
	1	2	3	4	@ 5%	1	2	3	4	@ 5%
Crown-root initiation	21	19	20	19.8	0.542	327	300	320	309	7.46
Tillering	31	30	33	30	3.127	461.3	445.5	405.8	445.5	39.17
Jointing	79.8	66.8	88.3	85.3	9.93	944.8	832.0	1012.8	993.8	87.09
Flag-leaf	93.8	83.5	98	100.8	3.66	1069.8	978.5	1108.8	1136.0	35.55
Boot stage	103.3	93.0	107.5	109.0	3.82	1161.0	1084.3	1207.3	1224.3	40.10
Ear emergency	121.5	116.0	124.0	126.3	2.78	1349.3	1289.5	1380.0	1412.3	35.85
Flowering	124.3	120.0	127.0	128.3	1.22	1384.0	1329.3	1419.0	1441.3	18.75
Watery grain	132.8	127.8	134.8	135.3	3.55	1514.0	1436.0	1549.8	1559.8	56.21
Milky grain	137.8	134.5	138.5	139.3	2.51	1610.3	1546.5	1625.0	1637.8	45.49
Soft dough	140.5	140.3	142.3	142.3	1.65	1658.8	1655.0	1689.5	1689.5	30.31
Hard dough	148.3	144.3	152.3	149.3	2.44	1740.0	1703.3	1726.3	1736.8	57.31
Physiological maturity	155.5	148.0	160.0	154.3	2.19	1973.0	1808.0	2060.0	1952.5	47.32

[*] Cultivars : (1) WL 711, (2) WL 1562, (3) WG 357 and (4) KSML 3

highest number of days and ACCDEG units for ear emergence which did not show significant differences with that of cv.WG 357. The cultivar differed significantly in terms of number of days and heat units for the completion of flowering stage. In attaining the watery-grain stage cvs. KSML-3, WG 357 and WL 711 differ significantly and for attaining the milky-grain stage (50%) cvs. KSML-3, WG 357 and WL 711 needed the same heat units as for watery-grain stage.

In the next phenological event (soft dough stage) cvs. KSML 3 and WG 357 required some number of days and heat units, which differed significantly as compared to cvs. WL 711 and WL 1562 which were significantly at par with each other. To reach the hard dough stage cvs. WL 711 and KSML-3 took the intermediate number of days/heat units being significantly at par with each other. For attaining the physiological maturity stage cvs. WG 357 and WL 1562 required maximum and minimum number of heat units (2060, 1808) respectively while the cvs. WL 711 and KSML-3 being statistically at par with each other and took intermediate number of heat units to mature where these were recorded to be 1973 and 1952.5 ACCDEG unit, respectively.

The present study suggest that, in any event, it seems desirable to explain how environmental variations affect phenology and physiological processes rather than merely to describe the outcome by statistical procedures[3]. Secondly, there is a varietal difference for attaining different growth stages. Thirdly, the number of heat units (ACCDEG units) are more important for the completion of different phenological events rather than number of days after sowing required for each stage.

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Comparative account of the clinical tests and amino-acid contents of the antigenic extracts of *Putranjiva roxburghii* Wall., *Cocos nucifera* L. and *Trewia nudiflora* L.

The vegetation of Calcutta and vicinity comprised mainly families Arecaceae, Asteraceae, Cyperaceae, Euphorbiaceae, Fabaceae, Poaceae, etc[1]. As *Putranjiva roxburghii* Wall., *Cocos nucifera* L. and *Trewia nudiflora* L. release large amount of pollen-grains in the air[2] and have been found to cause respiratory allergy in some cases[3], a study has been made to find out the comparative allergenic potency and the amino-acid composition of the antigenic proteins of these three allergenic plants.

Antigenic proteins have been extracted from the pollen-grains of *C. nucifera*, *P. roxburghii* and *T. nudiflora* following the standard technique of antigen extraction[4-6]. Skin sensitizing tests have been performed with the sterile antigen (1 : 50 and 1 : 500 dilution) on the patients suspected to be susceptible against these selected pollen grains (Tables 1-2). Amino-acid contents of the allergenic proteins have been determined following the technique of Moore *et al* [7]. One mg of dry protein sample from each pollen antigen was taken; after hydrolysis and subsequent drying,

TABLE 1 : Results of skin tests (antigen 1:50; w/v)

Pollen type	No. of patients/ healthy persons	Skin reaction				
		(-) negative	1+	2+	3+	4+
C. nucifera	P - 105	45	31	19	10	-
	H - 20	19	1	-	-	-
P. roxburghii	P - 97	41	33	15	8	-
	H - 20	20	-	-	-	-
T. nudiflora	P - 120	61	35	22	2	-
	H - 20	19	1	-	-	-

P = Patients; H = Healthy persons

TABLE 2 : Results of skin tests (antigen 1:500; w/v)

Pollen type	No. of patients/ healthy persons	Skin reaction				
		(-) negative	1+	2+	3+	4+
C. nucifera	P - 55	27	19	9	-	-
	H -15	15	-	-	-	-
P. roxburghii	P -39	20	15	4	-	-
	H -15	15	-	-	-	-
T. nudiflora	P - 41	23	13	5	-	-
	H -15	15	-	-	-	-

P = Patients; H = Healthy persons

amino acids were analysed in Beckman's automatic amino acid analyser. The results are summarised in Table 3. It has been found that *Cocos nucifera* gave significant positive results when compared with the results of *Trewia* and *Putranjiva*, although both *Trewia* and *Putranjiva* gave good number of positive results (Tables 1-2). Studies of amino-acid composition of the three pollen-grains indicated all the three antigenic protein sample contain altogether 17 amino acids. But the amounts vary from one genus to another. In case of *Cocos*, glutamic acid showed highest concentration followed by alanine, lysine, leucine etc. Glycine showed the highest concentration in case of *Putranjiva* followed by lysine, glutamic acid, tyrosine etc. In case of *Trewia* highest concentration has been shown by glycine followed by glutamic acid, aspartic acid etc (Table 3).

Those three pollen-grains were noted to be allergenic and their allergenic proteins were isoallergenic in nature when the amino-acid contents are concerned, remitting only a minor differences in the concentration of amino-acid of the three allergens. The skin tests were performed in the B. R. Singh Hospital, Eastern Railway, Sealdha, Calcutta- 700 014.

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TABLE 3 : Amino-acid composition of *C. nucifera, P. roxburghii* and *T. nudiflora*

Name of the amino acids	Micromoles of amino acid/ mg proteins sample of *C. nucifera*	Micromoles of amino acid/ mg proteins sample of *P. roxburghii*	Micromoles of amino acid/ mg proteins sample of *T. nudiflora*
Aspartic acid	2.3	1.50	1.97
Threonine	1.51	1.68	0.93
Serine	1.79	2.3	1.56
Glutamic acid	3.9	2.8	3.7
Glycine	1.7	3.1	3.9
Alanine	3.3	2.27	1.23
1/2 Cysteine	Trace	Trace	Trace
Valine	1.2	1.1	1.75
Methionine	0.73	0.9	0.40
Isoleucine	1.8	1.45	0.65
Leucine	2.9	1.9	1.25
Tyrosine	0.81	2.5	0.79
Phenylalanine	1.62	1.05	0.57
Proline	2.1	1.7	1.75
Lysine	3.2	2.83	1.34
Histidine	0.65	1.1	0.35
Arginine	1.25	2.1	1.16

Scanning of early-sprouting variety of mulberry

Morus alba, L. being the only stable food of silkworm is very useful if the leaf is broad and has got early-sprouting nature. Early-sprouting varieties can be beneficially exploited for early rearing in the spring season. In the present study, a few newly introduced as well as local varieties have been studied for early sprouting and large leaf area for the betterment of Sericulture Industry in Jammu region of J & K State.

In order to find out the leaf area, different methods have been enumerated[1, 2]. In the present investigation, mathematical relationship based on maximum leaf length and breadth was found to be more practical and appropriate[3]. Twelve varieties of *Morus* with entire leaf were taken into consideration. Well maintained plants of the same age group from different varieties were selected. Studies were initiated at a stage when most of the buds had just sprouted or about to sprout. Five first leaves of each variety were selected and tagged. Maximum leaf breadth was measured from the point where the leaf was found to be broadest. Maximum leaf length was measured from the point of attachment of petiole to the leaf to the leaf tip. Mean leaf area of different varieties was recorded (Table 1). Observations were recorded at 6-day intervals. Studies were also conducted during the next two concurrent years but similar results were obtained. It was observed that humidity and temperature have a marked effect on the growth of mulberry.

It was observed that Kanva-2, local and S-54 were the early sprouting varieties sprouting somewhere in the end of January or beginning of February. Sujanpur and Gosho-erami were the late sprouting varieties sprouting in the second week of February and third week of March. The rest of the varieties were found to be mid-time sprouting i.e. in the second week of February.

As per leaf growth and size gaining was concerned, Gosho-erami had fast-growing leaf. Sujanpur, $BC_2$59, TR-4 Behrampur, TR-10 Behrampur and Local had slow-growing leaf with lesser leaf area (Table 1). Kanva-2, Gosho-

TABLE 1 : Datewise leaf area estimates of twelve *Morus* varieties in Jammu region

Date	7.2.85	13.2.85	19 2.85	25.2.85	3.3.85	9.3.85	15.3.85	21.3.85	Percent increase in leaf area on initial observation
Max.Temp./ Min.Temp.	22.5/5.5	22.0/5.5	25.0/6.0	26.0/8.0	30.0/10	31/11	33.5/12	35/14	
Relative humidity	80%	70%	64%	64%	60%	63%	60%	58%	
Variety					Leaf area (cm^2)				
S - 36	2.26	3.78	14.35	21.58	37.67	59.20	81.50	98.60	4262.8
S - 54	7.76	17.58	29.42	32.10	71.92	78.08	90.58	120.60	1454.1
S - 41	3.61	8.25	17.73	21.41	69.62	79.82	85.60	102.62	2742 6
S - 30	3.98	11.16	24.65	26.95	51.80	118.95	115.00	122.96	2989.4
Kanva -2	10.14	19.61	40.11	58.23	78.72	98.67	104.00	130.50	1186.9
CSIR Mysore 8	4.30	7.79	14.87	22.82	27.86	34.08	50.00	86.05	1901.2
TR - 4 Behrampur	4.11	5.93	11.29	13.44	14.06	35.28	54.50	101.30	2364.7
BC_2 - 59	3.91	8.91	12.24	14.23.	15.82	16.22	30.50	65.15	1566.2
TR - 10 Behrampur	3.58	7.54	13.08	16.12.	16.68	18.08	33.70	62.05	1633.2
Sujanpur	1.60	5.29	8.75	10.55	19.39	22.15	28.60	47.72	2882.5
Local	9.76	11.07	13.86	23.06	36.74	56.80	54.80	57.58	489.9
Gosho-erami	-	-	-	-	-	-	5.92	94.58	-

* Percent increase in leaf area = $\frac{b - a}{a} \times 100$

Where a = the initial leaf area

b = the final leaf area

erami had very good leaf yield, whereas local and CSIR Mysore-8 had poor leaf yield. The statistical analysis based on initial observation calculated showed some deviation which may perhaps be because Kanva-2 initially had more leaf area in comparison to the other varieties. But the variety had better leaf yield as compared to others. After feeding trial of all varieties to various races of silkworm, it was noted that leaves of Kanva-2 and Gosho-erami were more palatable and liked by the silkworms. In contrast to this, Sujanpur[4] and CSIR Mysore-8 had low palatability.

From above findings, it is clear that variety Kanva-2 is best suited for early rearing in Jammu region. Hence, it is recommended to be cultivated in this area. Gosho-erami should better be cultivated in Kashmir region where early rearing is not needed but the variety should have good leaf yield, better palatability and larger leaf area.

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Population growth behaviour of *Tylenchorhynchus mashhoodi* and *Criconemella ornata* as influenced by wheat varieties

Population growth behaviour of phytofeeding nematodes in any varietal resistance trial can be taken as one of the parameters for evaluation of status of host, as being obligate parasites, nematodes are influenced by their host physiology. Efficient hosts are those upon which nematodes can build up great densities compared to poor hosts where population density is low[1].

To study the influence of wheat varieties on the population growth behaviour of two phyto-feeding nematodes *Tylenchorhynchus mashhoodi* Siddiqi and Basir, 1959 and *Criconemella ornata* Luc and Raski, 1981, soil samples were collected for four times at an interval of one month starting from sowing from a wheat varietal trial comprising of sixteen entries laid out in Randomised Block design with three replications in the University central farm. Nematodes were recovered from soil following Cobb's shifting and gravity method, killed in hot water and preserved in 2% formaline in water. Populations of the nematode free in the soil were counted species-wise and analysed statistically following $\sqrt{n+1}$ transformations. Reproductive rate (R) was calculated by dividing the final population (Pf) at harvest by the initial population (Pi) at sowing. The data are presented in Table 1. Different populations of *T. mashhoodi* and *C. ornata* exhibited slow but distinct rising trends of growth in all varieties from sowing (D_1) upto post flowering (D_3) which indicate that the varieties had served as hosts for the nematodes. While populations of the two species on majority of the varieties declined upto harvest (D_4), only two in case of *T. mashhoodi* (HI-1077 and Kalyansona) and five in case of *C. ornata* (HI-1077, Sonalika, HI-1156, K.Sona and HI-1116) increased upto harvest. Almost all the varieties supported the populations of *T. mashhoodi* and thirteen varieties excepting Raj-1182, HD 2402 and HI-1156 supported latter population upto third date levels. These trends indicate that influence of stages of wheat growth on the population growth of the two nematode species was variable depending on wheat varieties and nematode species, majority of the varieties, but not all, restricting nematode growth beyond flowering and not before.

'R' (times-growth) values of the two nematode species range from 0.5 to 3.2 and 1.2 to 6.0 in case of *T. mashhoodi* and *C. ornata* respectively. *Tylenchorhynchus* spp. perhaps are

TABLE 1 : Population Dynamic of *Tylenchorhynchus mashhoodi* & *Criconemella ornata* in a wheat varietal trial (Mean tables for Varieties, Dates and V x D interactions)

Varieties	(A) *Tylenchorhynchus mashhoodi*						(B) *Criconemella ornata*					
	D_1	D_2	D_3	D_4	Mean	R**	D_1	D_2	D_3	D_4	Mean	R**
HD-2402	7.4	8.5	12.0	5.9	8.4	0.6	2.0	1.7	2.2	4.3	2.5	6.0
HI-1077	4.9	5.6	7.9	8.4	6.7	3.0	1.7	2.0	2.8	3.3	2.4	5.0
Sonalika	5.1	6.2	8.8	4.4	6.1	0.7	1.7	1.7	1.7	2.4	1.9	3.0
HI-1156	4.3	5.0	7.1	5.5	5.5	1.6	2.0	2.2	2.2	3.2	2.4	3.0
K. Sona	3.7	4.2	5.8	6.5	5.0	3.2	2.2	2.3	2.6	3.4	2.6	2.8
Lok-1	5.5	6.2	8.8	4.6	6.3	0.7	2.3	2.7	3.9	3.7	3.2	2.6
HI-1116	4.6	5.4	7.4	5.5	5.7	1.4	2.2	2.2	3.0	3.3	2.7	2.5
CPAN-1998	6.5	7.4	10.5	6.0	7.6	0.9	2.8	3.2	4.3	4.1	3.6	2.3
HI-1076	4.1	4.7	6.5	4.9	5.0	1.4	2.1	2.6	3.5	3.4	2.9	2.2
HI-1115	5.2	5.9	8.2	5.3	6.2	1.0	2.4	2.4	3.6	3.1	2.9	1.8
HI-784(Swati)	4.4	5.2	7.3	6.1	5.7	1.9	2.2	2.4	3.1	2.8	2.6	1.7
HD-2411	5.0	5.6	7.9	5.5	6.0	1.2	2.4	2.2	3.0	2.9	2.6	1.6
HD-2444	5.6	6.5	9.2	4.2	6.3	0.5	2.4	2.6	3.9	2.9	2.9	1.6
HD-2399	5.5	6.2	8.8	5.2	6.4	0.9	2.6	2.8	3.8	3.2	3.1	1.5
Raj-1482	5.1	5.9	8.3	5.3	6.2	1.1	2.3	2.6	1.0	2.8	2.2	1.4
HI-1144	5.8	6.8	9.6	5.7	6.9	0.9	2.6	3.0	4.2	2.8	3.1	1.2
Mean	5.2	5.9	8.4	5.6			2.3	2.4	3.0	3.2	-	-

Population at different dates* and final R** values

	(A)	(B)
C.D.(0.05) Varieties	0.5	0.3
Dates	0.3	0.1
Interactions	1.1	0.6

*Mean $\sqrt{n+1}$ transformed values of three replications

**Based on non-transformed values.

not as prolific breeders as other species. Ray and Patra[2] observed. *T. cuticaudatus* to have 'R' values ranging from 0.75 to 3.6 on groundnut. Considered in the light of aforesaid observation, 56% of the wheat varieties on which 'R' values of *T. mashhoodi* are more than one can be treated as efficient (susceptible/tolerant) hosts compared to the rest 44% which are inefficient (= resistant) hosts because of 'R' values which are less than one.

Criconemella ornata has been seen earlier to have 'R' values as high as 72.9 (range 38.1 to 72.9) on groundnut (Ray and Patra[3]) and in comparison, the 'R' values of the species obtained here on wheat are decisively very low which lead to assume that all the wheat varieties under study are inefficient (=resistant) hosts for the nematode.

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Varietal response of paddy to storage conditions

Viability is an important physiological factor that determines the life span of seed of high yielding variety paddy especially for the flood and drought affected areas of Orissa. It was reported[1] that paddy seed can be stored for two to three years at low temperatures if it contains less than 13% of grain moisture. Different genotypes respond[2] differently to storage conditions for which the present study was undertaken to evaluate 12 popular paddy varieties of 90-135 days duration with dormancy up to one month only in CR 1014 and Jagannath.

The experiments were conducted during March 1981 from samples harvested during October-December, 1980. Samples of 100 seeds from each variety were packed in polythene bags of 300 gauge, sealed and stored for 120 days under controlled temperatures, ranging from -3 to 40 C. Seeds stored at room temperature served as control. At the end of storage period, viability was estimated[3] as percentage of germination and the data were analysed statistically.

The data (Table 1) revealed a significant temperature x variety interaction indicating that the viability of a variety is influenced by the storage temperature. At room temperature viability of Kalakeri, CR-1014, Ratna and NC-1281 was superior to other test varieties. Similarly, at -3°C, Dular, NC-1281, Kalakeri, CR-1014, Black-gora, CR-34-7, Bala and Ratna were superior to others. At 8°C, NC-1281, Black-gora, Jagannath and Ratna showed better viability estimates. At 16°C, Ratna, Kalakeri, NC-1281, CR-1014, Brown-gora, Black-gora, Jagannath and Dular possessed better viability values. At 27°C, NC-1281, Kalakeri, CR-1014, Black-gora and Ratna exhibited superior viability estimates. At 30°C, viability of Jagannath was superior to all other test varieties. At 37°C, Jagannath, Kalakeri, CR-1014, Black-gora and Ratna were found to possess superior viability values. At 40°C, Black-gora, NC-1281, Jagannath and Ratna manifested superior viability values.

It might be noted that a germination value of 80% (63.44 a.v.) is the minimum requirement for certification of paddy seeds[4]. In this context, seeds of Ratna, Dular, NC-1281,

TABLE 1 : Effect of storage temperature on the germination percentage of paddy seeds

Variety	Storage temperature in °C (angular values of %)								Variety means
	RT	– 3°C	8°C	16°C	27°C	30°C	37°C	40°C	
Kalakeri	84.2	78.8	77.1	78 8	78.8	73.7	80.2	76.0	78.5
Dular	70.6	84.2	73.6	77.1	75.0	71.9	77.1	74.7	75.5
NC-1281	78.5	85.9	90.0	80.1	84.2	78.8	77.7	80.7	82.0
CR-1014	84.2	78.8	77.1	78.8	78.8	73.7	80.2	76.0	78.5
Brown-gora	76.0	72.6	77.7	78 8	73.2	70.6	77.1	76.7	75.3
Black-gora	69.7	77.7	85.9	78.8	80.2	77.1	80.8	85.9	79.5
Jagannath	76.0	67.2	84.2	77.1	77.1	90.0	85.9	78.8	79.4
Saturn	45.0	62.7	68.9	58.1	46.7	45.6	57.6	57.4	55.3
Bala	56.8	72.6	66.5	71.9	63.5	52.0	71.1	68.9	65.4
Kalinga-2	66.4	68.9	74.7	69.8	72.8	64.2	74.7	76.0	70.9
Ratna	78.5	74.7	85.9	81.9	80.2	76.0	82.9	82.9	80.4
CR-34-7	66.4	77.1	80.1	72.8	75.8	70 0	76.7	71.7	73.8
Temp. means	70.2	75.1	78.5	75.3	74.0	70.3	76.8	75.5	

C.D. (0.05) for temperature = 3.2; Variety = 5.5
temperature x variety = 8.1;
R.T.— Room temperature:
Maximum = 31.7°C ± 4°C
Minimum = 29.5°C ± 5°C

CR-1014, Brown-gora, Black-gora and Saturn did not satisfy the minimum requirement initially but improved during storage, except saturn. Such improvement may be attributed[5] to the period of storage rather than storage temperature since they are known to possess varying period of dormancy. The results of the present study, however, confirm the earlier findings[6,7].

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Additional vector of citrus tristeza virus

Citrus tristeza is one of the most destructive virus disease among all the virus and virus-like diseases of citrus. During the extensive surveys undertaken to assess the performance of pre-immunized and healthy acid lime [(*Citrus aurantifolia* (Christem) Swing.] seedlings in growers' orchards in Karnataka, Andhra Pradesh and Tamil Nadu states, severe strain symptoms and decline were observed to varying extent within 2-8 years after planting. Severe strain symptoms were observed to be spreading fast even in those orchards where periodical insecticidal sprays were undertaken and colonization of aphids on acid lime was absent. In view of these observations, investigations were undertaken to study the role of different aphids in spreading this dreadful disease.

Colonies of aphids were raised from single females on their respective hosts, enclosed in wire mesh cages, viz., *Myzus persicae* Sulz. on tobacco, *Aphis gossypii* Glov. on bottelgourd *A. craccivora* Koch. on cowpea, *A. nerii* Boy. on *Calatropis*, *A. fabae* Scop. on broadbean, *Acyrthosiphon pisum* Harris. on sweet pea and *Toxoptera citricida* Kirk. on sweet orange. In all the experiments well developed apterous adults were used for transmission studies. Acid lime seedlings, 4-6 month old, planted singly in polythene bags and having 8-10 leaves were used as test plants. Cultures of mild and severe strains of citrus tristeza virus (CTV) were maintained separately on acid lime plants. Aphids were starved for 2-3 hours in dark, given an acquisition access time of 30 minutes on detached young leaves showing typical symptoms of mild and severe strains separately and thereafter transferred in groups of 10 aphids/test plant for providing inoculation access time of 24 hours. Thereafter, the plants were sprayed with 0.05% dimethoate solution to kill the aphids and observation for symptoms were made upto 4 months. For each aphid species and strain of the virus, three replications, each having 10 plants, were maintained. All experiments were carried out under insect-proof glasshouse conditions. Data were subjected to angular transformation before analysis of variance[1].

All the aphid species tested transmitted both mild and severe strains of CTV (Table 1). However, severe strain was transmitted more efficiently than mild strain by all the aphids. *T. citricida* was the most efficient vector for both the strains and *A. nerii* was the least efficient vector. *A. fabae* and *A. nerii*; *A. fabae, A. gossypii* and *A. pisum;* and *A. craccivora* and *M. persicae* did not differ statistically from each other for transmitting severe strain. *A. fabae* and *A. nerii*, and the other five aphid species were at par among them-

TABLE 1 : Transmission of citrus tristeza virus strains by different aphids

Sl. No.	Aphid species tested	Percent transmission of strains Severe	Percent transmission of strains Mild
1	*Aphis craccivora*	44.98 (50.00)*	30.98 (26.33)
2	*A. gossypii*	30.98 (26.66)	28.76 (23.33)
3	*A. fabae*	23.84 (16.66)	8.85 (6.66)
4	*A. nerii*	14.99 ((10.00)	6.14 (3.33)
5	*Acyrthosiphon pisum*	30.98 (26.66)	23.84 (16.66)
6	*Myzus persicae*	46.90 (53.33)	32.98 (30.00)
7	*Toxoptera citricida*	74.98 (90.00)	34.98 (33.33)
	'F'	20.408	5.3371
	S.Em ±	4.3559	5.0643
	C.D. 5%	13.4163	15.5981

* Data in the parenthesis represent actual values and outside transformed ($\sqrt{X+1}$) values

selves for mild strain. Transmission of CTV in India has been reported through *T. citricida*[2], *A. gossypii, A. craccivora, M. persicae, Dactynotus jaceae*[3], *A. spiraecola, T. aurantii*[4,5] and *A. citricola*[6]. *A. fabae, A. nerii* and *A. pisum* are additional vectors of CTV. High rate of aphid transmission of severe strain by all the aphid species may be the reason for more prevalence and faster spread of severe strain. Similar variations in the vector transmission of different isolates/strains of CTV have been reported earlier[7-9]. Moreover, relative importance of colonizing and non-colonizing aphids as vectors has to be evaluated more carefully as non-colonizing aphids have been reported to be more efficient vectors[10]. *A. fabae, A. nerii* and *A. pisum* are here reported for the first time as the vectors of CTV strains.

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Nitrogen fixation by *Klebsiella rubiacearum*

While N_2-fixation by *Klebsiella pneumoniae* is now well established[1], N_2-fixation by *K. rubiacearum*, an organism isolated from the leaf galls of *Psychotria* (Rubiaceae) first observed by Silver and Centifanto[2] is disputed and this species of *Klebsiella* does not figure in Postgate's list[1]. We have examined N_2-fixation by a strain of *K. rubiacearum* obtained from J. Deley, Belgium.

K. rubiacearum was extensively purified by treatment with 100 µg. ml^{-1} of penicillin, ampicillin, streptomycin, kanamycin and tetracycline. The bacterium survived this treatment except that 100 µg. ml^{-1} of tetracycline was toxic. Cells, obtained after treatment of sublethal concentration of antibiotics, were subjected to extensive dilution plating and purity was checked by scanning electron microscopy using a Phillips EM400 at RSIC, Bose Institute, Calcutta (Fig. 1).

Fig. 1 : Scanning electron micrograph of *K. rubiacearum*. The white bar represents 1 µm.

The organism fixed 24.86 mg of N_2 per litre of culture media; in terms of glucose it fixed 3.31 mg per gram of glucose consumed. Fig. 2 shows that *K. rubiacearum* has a lag period of about 6 hr before the cells exhibit nitrogenase activity as indicated by acetylene reduction using a Hewlett-Packard gas chromatograph fitted with a hydrogen flame ionization detector and Porapak N column. The experiment was carried out for 45 hr and for 34 hr the activity increased progressively with time. The rate of reduction was about 158 nmole mg^{-1} cell dry wt. h^{-1}.

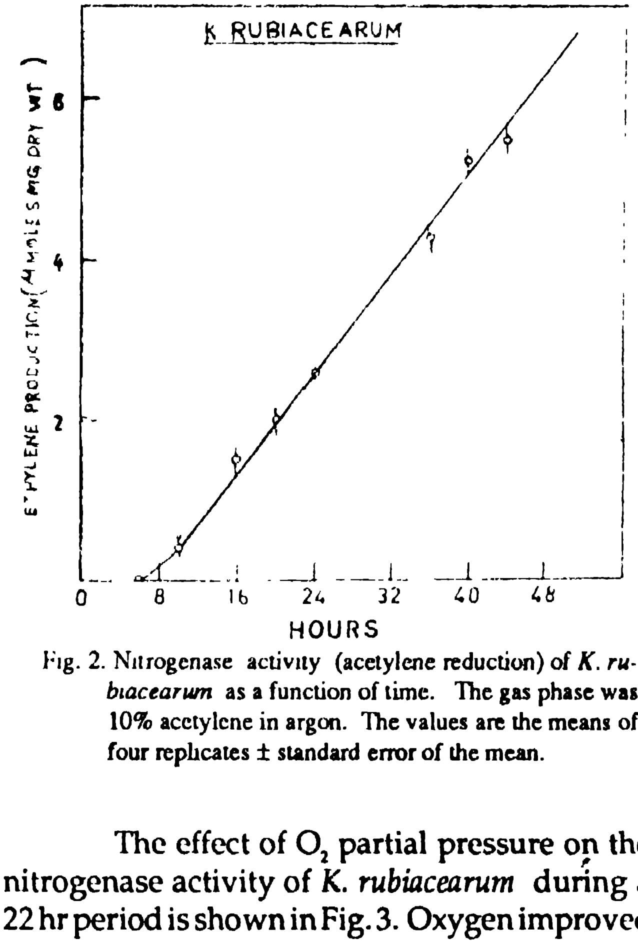

Fig. 2. Nitrogenase activity (acetylene reduction) of *K. rubiacearum* as a function of time. The gas phase was 10% acetylene in argon. The values are the means of four replicates ± standard error of the mean.

The effect of O_2 partial pressure on the nitrogenase activity of *K. rubiacearum* during a 22 hr period is shown in Fig. 3. Oxygen improved nitrogenase activity up to a pO_2 of 0.02 atm, when the increment was of the order of 50% as compared to the anoxic condition but thereafter the effect was inhibitory, the inhibition increasing with increase in O_2 concentration. At a pO_2 of 0.055, the acetylene reduction was practically the same as in complete absence of O_2; in air, the activity dropped down to about 1/3rd of the rate observed under anaerobic conditions.

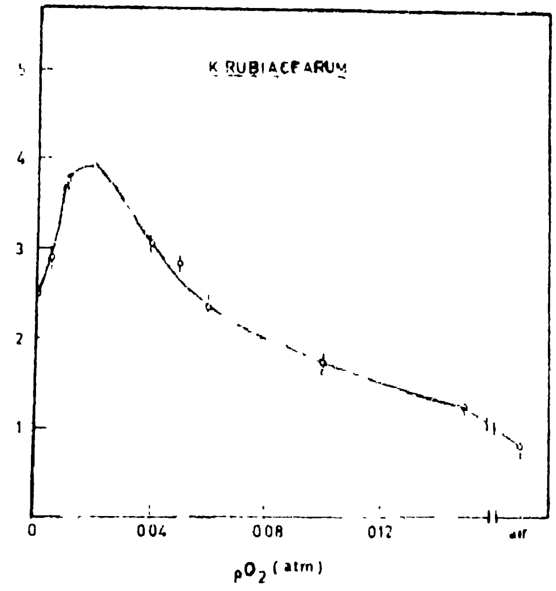

Fig. 3. Effect of different concentrations of O_2 on nitrogenase activity (acetylene reduction) of *K. rubiacearum*.

Orskov[3] recognised 32 biotypes of *K. pneumoniae* alone and Bascomb *et al.*[4] divided the Klebsiellae into six taxa. N_2-fixing strains of *Klebsiella* are widespread in the phylloplane of plants particularly in the tropics[5]. The *nif* gene cluster in *K. pneumoniae* M5 a1 is integrated with the genome[1], whereas it is plasmid-carried in the strains of *Klebsiella* isolated from the phylloplane. If the *nif* gene in *K. rubiacearum* also is plasmid-carried, the loss of N_2-fixing capacity in some strains can be explained since plasmid-borne characters are known to disappear in the progeny under conditions which encourage non-synchronous division.

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Effect of growth substances on fruit set and fruit retention in guava

The initial fruit-set is distinctly high in guava (*Psidium guajava* L.) and about 80-86% of flowers set fruits[1]. Due to severe fruit drop, only 34-56% of fruits attain maturity. Spraying of GA_3 at 15 or 30 mg/l in the month of January proved effective in increasing fruit retention and subsequently the yield[2]. About 90% fruits[3] were retained in trees receiving 200 mg/l GA_3.

The present experiment was carried out on guava cv. L-49. For each treatment, 110-230 open flowers were tagged and used. The flowers were sprayed once with different growth regulators at various concentration (Table 1) with the help of an atomizer. The number of fruits formed on the treated flowers were counted 20 days after the treatment. The chemicals were further sprayed 7 days after the formation of fruits and 90-155 fruits were used per treatment. The number of fruits retained on the plant till harvest was recorded.

The different treatments indicated 5-18% increased fruit set compared to control, except 2, 4-D at 50 mg/l treatment, which caused deblossoming by about 15% compared to control. The effect of GA_3 was, however, found most effective at all concentrations. Among the various growth substances, NAA at 50 mg/l appreciably reduced the drop of immature fruits (Table 1). Treatment with different growth substances caused 10.1-35.4% more fruits at harvest compared to control.

To increase fruit set, we need to reduce the relative 'sink strength' of the young fruits and growth regulators was found effective in this way[4]. The use of GA_3 (ber), NAA (mango) and 2, 4-D (orange) in increasing fruit set and reducing fruit drop was earlier reported[5-7]

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TABLE 1 : Effect of growth substances on fruit set and fruit retention in guava (cv. L-49)

Treatment	Number of flowers treated	Percentage of fruits set	Number of fruits treated	Number of fruits harvested	Percentage of fruits harvested
GA_3 50 mg/l	155	92	110	94	85.5
GA_3 100 mg/l	178	98	130	112	96.2
GA_3 200 mg/l	135	90	125	108	86.4
2, 4-D 5 mg/l	230	87	145	123	84.8
2, 4-D 10 mg/l	185	90	105	83	79.0
2, 4-D 50 mg/l	205	65	155	102	65.8
NAA 10 mg/l	175	85	112	96	85.7
NAA 50 mg/l	110	85	90	82	91.1
NAA 100 mg/l	180	92	135	111	82.2
Control	142	80	140	78	55.7

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Effect of Cd^{++} on amylase activity during germination of *Arachis hypogea* (Co I)

Cadmium is a major environmental pollutant. Atmospheric Cd sources are primarily metal processing or impurities in Zn-base oil and rubber additives that are released when diesel and heating oils are burned or vehicle tyres wear[1]. Raised concentration of Cd in soil may be due to pollution from mining or smelting or from automobiles[2]. Cd is also a water pollutant[3]. Increased amounts of Cd in water may be due to industrial discharges or from the metal and plastic pipes used in water distribution[4]. Phosphate fertilizers and pesticides may also contribute significantly[5] Cd has been found to be toxic to lichens when 300-500 ppm accumulated in the thallus[6]. Reduced plant growth and chlorosis have been observed as a result of exposure to Cd[7]. Other effects observed include reduced photosynthesis and transpiration rates[8] and increased occurrence of ozone-induced leaf injury[9]. Cd has also been known to interact with Cu in causing growth retardation[10]. The present study was undertaken with a view to study the effect of Cd on germination of *Arachis hypogea*. The enzyme amylase was chosen for this purpose as this enzyme has been shown to be affected by heavy metals[11].

Archis hypogea (Co I) seeds were obtained from Tamilnadu Agricultural University, Coimbatore. The seeds were soaked in different concentration of $CdCl_2$ for three hours. Seeds soaked in distilled water served as the control. After three hours the seeds were spread out on petridishes on filter paper and allowed to germinate. Germination was follwed for five days during which period the activity of amylase and the carbohydrate content in cotyledons were measured. The enzyme extract for assay of amylase was prepared from cotyledons according to the method of Azhar and Krishnamoorthy[12]. Amylase activity was measured by the dinitrosalicylic acid method[13] and carbohydrates by the phenol-sulphuric acid method[14].

Table 1 shows that the activity of amylase increases from day 1 to day 5 in the cotyledons of the control group. A similar pattern was obtained for the test groups as well but the activity is comparatively less indicating the inhibitory effect of Cd^{++} on amylase. For each day the

TABLE 1 : Effect of Cd^{++} on amylase activity and carbohydrate content in cotyledons in germinating *Arachis hypogea*

	Amylase (mg maltose liberated/cotyledon)				Carbohydrate (mg/100 mg cotyledon)			
Days	10^{-2}M $CdCl_2$	10^{-3}M $CdCl_2$	10^{-4}M $CdCl_2$	Control	10^{-2}M $CdCl_2$	10^{-3}M $CdCl_2$	10^{-4}M $CdCl_2$	Control
1	0.039± 0.001	0.044± 0.001	0.081± 0.002	0.101± 0.003	36.35± 0.99	31.55± 0.87	26.53± 0.96	18.63± 0.54
2	0.073± 0.002	0.144± 0.004	0.190± 0.004	0.315± 0.007	12.48± 0.63	9.21± 0.41	7.26± 0.26	6.42± 0.27
3	0.116± 0.002	0.243± 0.007	0.399± 0.004	0.575± 0.015	9.49± 0.50	6.68± 0.18	5.45± 0.27	3.61± 0.15
4	0.171± 0.003	0.280± 0.008	0.495± 0.020	0.936± 0.033	6.31± 0.24	5.37± 0.19	4.92± 0.10	3.01± 0.06
5	0.209± 0.010	0.320± 0.010	0.583± 0.031	1.010± 0.056	5.11± 0.15	4.10± 0.16	3.23± 0.08	2.11± 0.08

TABLE 2 : Effect of Cd^{++} on fresh weight and root length in germinating *Arachis hypogea*

	Average fresh weight (g)				Root Length (cm)			
Days	10^{-2}M $CdCl_2$	10^{-3}M $CdCl_2$	10^{-4}M $CdCl_2$	Control	10^{-2}M $CdCl_2$	10^{-3}M $CdCl_2$	10^{-4}M $CdCl_2$	Control
0	0.312± 0.006	0.315± 0.007	0.320± 0.012	0.320± 0.017	-	-	-	-
1	0.440± 0.021	0.463± 0.016	0.516± 0.023	0.533± 0.030	-	0.3	0.6	0.9
2	0.461± 0.009	0.501± 0.021	0.578± 0.028	0.595± 0.021	0.3	1.1	1.4	1.7
3	0.513± 0.027	0.550± 0.023	0.625± 0.031	0.671± 0.033	0.8	1.8	2.1	2.7
4	0.554± 0.017	0.610± 0.033	0.731± 0.043	0.764± 0.055	1.4	2.4	3.2	4.1
5	0.590± 0.021	0.709± 0.021	0.860± 0.036	0.900± 0.045	1.9	3.3	4.6	5.8

inhibition by Cd^{++} increase in Cd^{++} concentration. In contrast to this, the carbohydrate content in cotyledons falls from day 1 to day 5 in the control group. A similar pattern is seen in the test groups but the levels are higher. For each day the carbohydrate content increased with concentration of Cd^{++}. The results in Table 2 also clearly indicate that Cd^{++} has an inhibitory effect on germination in *Arachis hypogea.* Cd^{++} has strong affinity for —SH groups[15]. Thus, it is likely that Cd^{++} inhibits germination in *Arachis hypogea* by interfering with the functioning of a vital—SH group.

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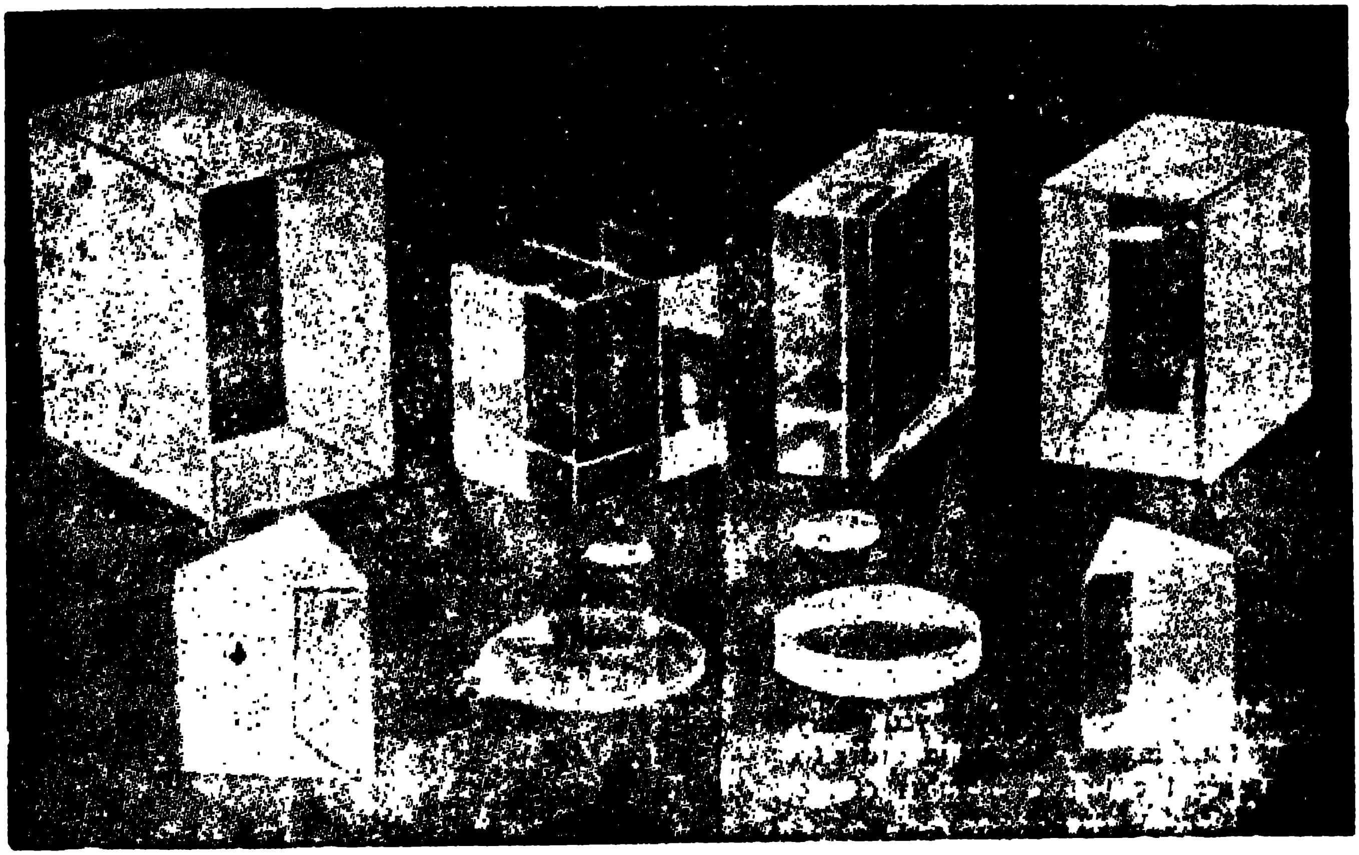

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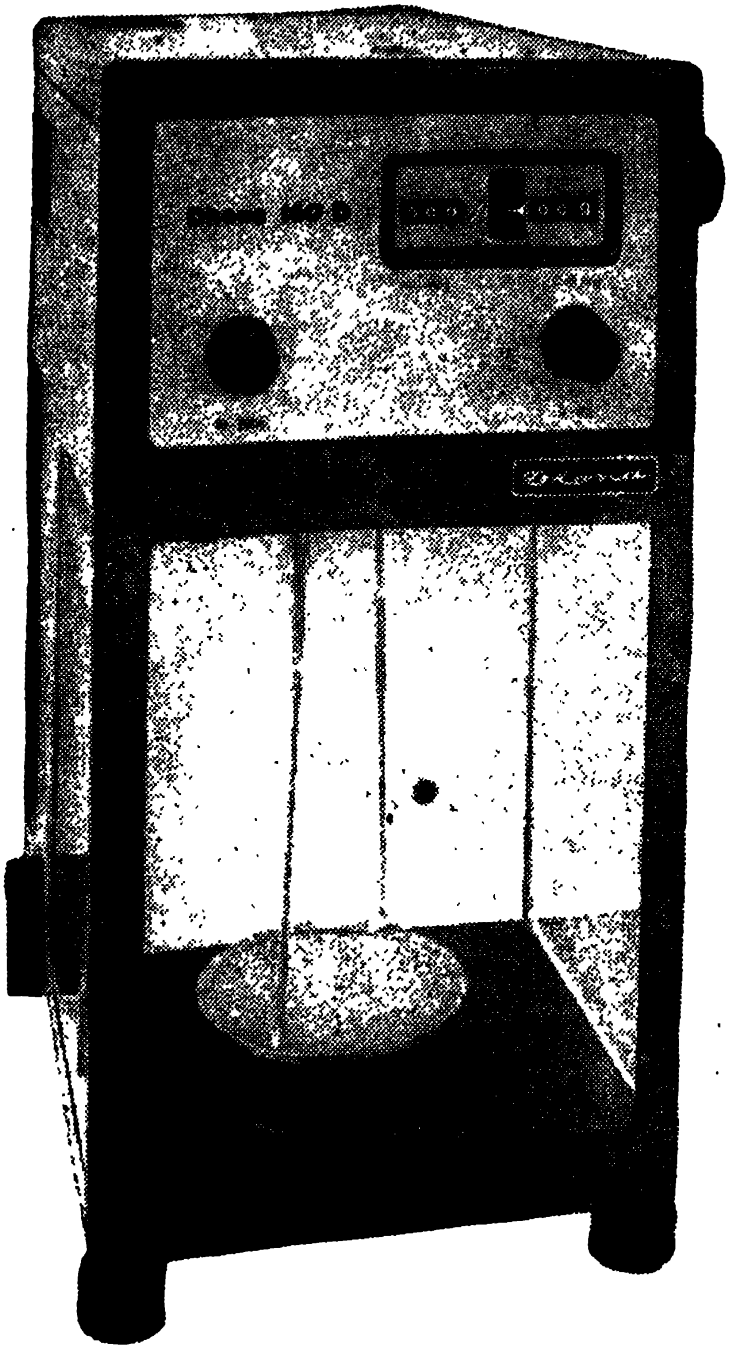

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6. (i) R. B. Walton and H. B. Woodruff, *F. Clin. Inst.*, **82**, 924, 1949.
   (ii) W. C. Boyd, Fundamentals of Immunology, 1947, p. 123. (Interscience Publishers Inc., New York).

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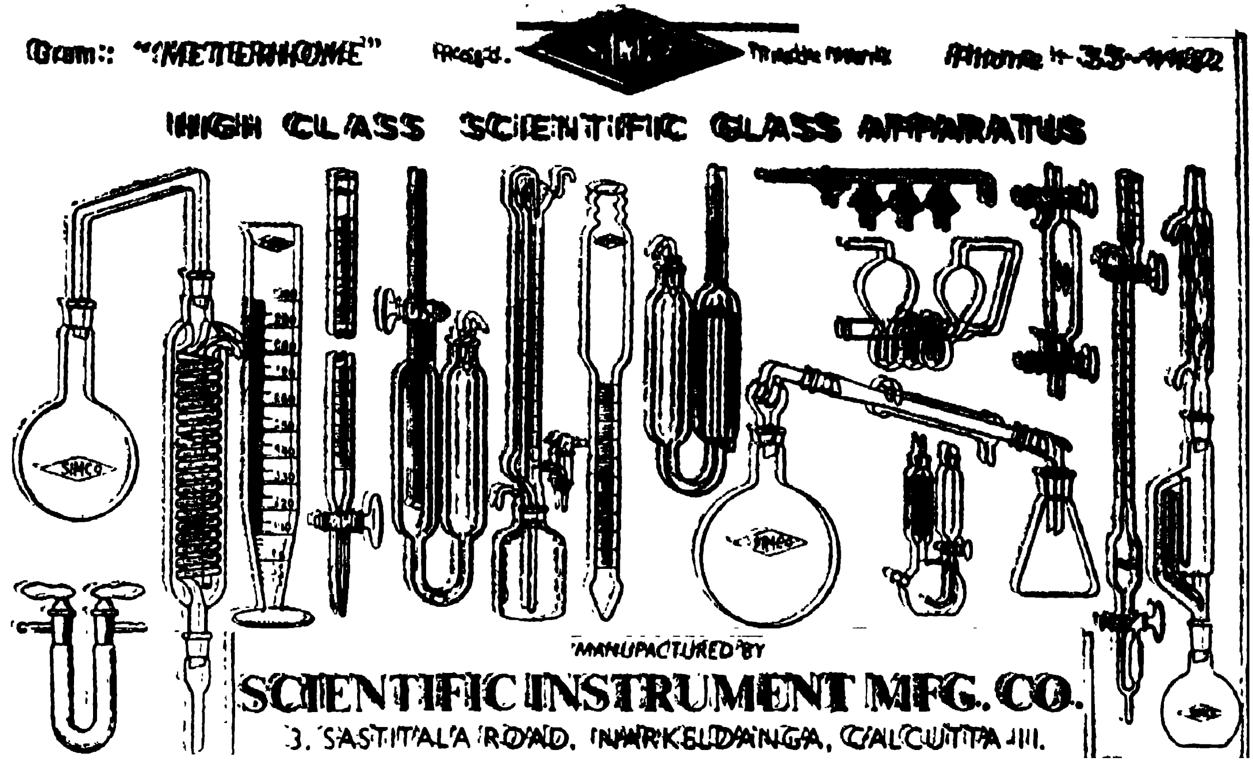

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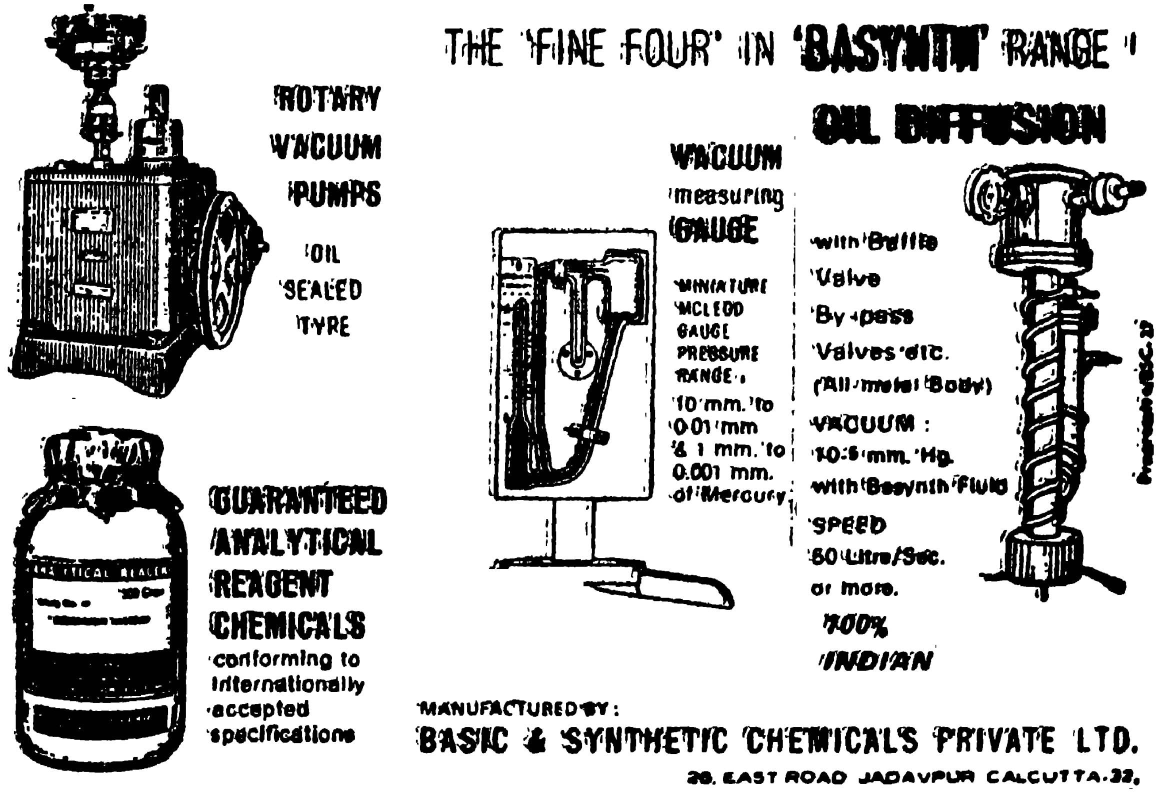

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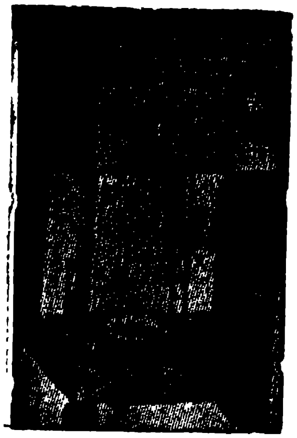

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FELLOWSHIP OF THE ROYAL SOCIETY

'THE Royal Society of London for Improving Natural Knowledge' or in short, the 'Royal Society' is the oldest scientific society in Great Britain and one of the oldest in Europe. The Society was founded in November 1660 through the efforts of a group of about twelve eminent British Scientists of whom Robert Boyle was one of the leading members. King Charles II granted the Society its first Charter on 15th July 1662 which was followed by a second Charter on 22nd April 1663, extending the society's privileges.

'*Nullius in verba*—an expression of determination to withstand dogma and to verify all statements by an appeal to facts', was chosen as the motto of the society. Besides advising the Government in connection with scientific undertakings of national importance, the society had always the authority of appointing the British delegates to the meetings of the International Research Councils. One of the most important duties which the Royal Society performs on behalf of the government is the administration of the annual grants for the promotion of scientific research in different disciplines and also for the International Collaboration and Exchange Programmes with other Academies[*].

The fellowship of the Royal Society is considered as an international recognition of the eminence of a scientist. The list of the Fellows includes illustrious names like *Newton, Davy, Faraday, Rutherford, Thomson, Eddington, Bragg, Einstein, Bohr, Dirac,* and many others whose contributions led to the evolution and further expansion of the frontiers of knowledge in the different branches of Science and Technology. Besides renowned scientists from the Commonwealth countries and the Irish Republic, 'foreign members are selected by the Council from among men of the greatest scientific eminence abroad, and proposed to the Society for election'. The current fellowship list consists of a little over one thousand fellows and the same for foreign members nearly one hundred.

The first Indian to be elected as a Fellow of the Royal Society was *Ardaseer Cursetjee* (1808–1877). He was elected as early as 1841 in recognition of his pioneering work in the art of ship building and in the improvement of the associated engineering techniques. After nearly a span of seventy seven years, the mathematical genius, *Srinivasa Ramanujan* was elected in 1918, followed by *Jagadish Chandra Bose* in 1920. Since then many other distinguished Indian scientists have been elected to the prestigious Fellowship at the rate of atleast one or a few per decade. The names adorning the list are given hereunder with their respective years of election:

Ardaseer Cursetjee (1841); *S. Ramanujan* (1918), *J. C. Bose* (1920); *C. V. Raman* (1924); *M. N. Saha* (1927); *Birbal Sahni* (1936); *K S. Krishnan* (1940); *H. J. Bhabha* (1941); *S S. Bhatnagar* (1943); *P. C. Mahalanobis* (1945); *D. N. Wadia* (1957), *S. N. Bose* and *S. K. Mitra* (1958); *T R.*

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[*] *Particular mention may be made of the exchange programmes with India. The National Institute of Sciences of India—NISI (renamed as the Indian National Science Academy—INSA in February 1970) was established in January 1935 on the model of the Royal Society, London. Besides the regular two way exchange programmes there is an additional link with the INSA through the Blackett Memorial Lecture This was established jointly by the Royal Society and the INSA in 1975 The lecture is being delivered every second year alternately in India by a British Scientist and in Britain by an Indian Scientist.*

Seshadri (1960); *P. Maheswari* (1965); *C. R. Rao* (1967); *M. G. K. Menon* (1970); *B. P. Pal* (1972); *M. S. Swaminathan* (1973); *G. N. Ramachandran* (1977); *D. Lal* (1979); *A. S. Paintal* (1981); *C. N. R. Rao* (1982); *S. Chandrasekhar* (1983); *Obaid Siddiqui* (1984); *R. Ramalingaswami* (1986); *C. Gopalan* (1987); *A. P. Mitra* and *C. S. Seshadri* (1988).

The broad subject wise distribution of the Fellowships is as follows : Physics (12); Chemistry and Medical Sciences (3 each); Mathematics, Statistics, Botany and Agricultural Sciences (2 each) and Engineering Sciences, Molecular Biology and Geological Sciences (1 each). Of these twenty-nine illustrious Indian scientists, fifteen Fellows have since passed away.

Dr. A. P. Mitra, Director General, Council of Scientific and Industrial Research, Government of India, and Dr. C. S. Seshadri, Professor, Institute of Mathematical Sciences, Madras have been elected to the Fellowship of the Royal Society this year. As is the usual custom, in a solemn function at an early date they will be individually received by the President of the Royal Society in London with these words : *'I do, by the authority and in the name of the Royal Society of London for improving natural knowledge, admit you a Fellow thereof'*.

The election of Dr. A. P. Mitra and of Dr. C. S. Seshadri to the prestigious Fellowship of the Royal Society is an honourable recognition of their personal contributions for *'Improving Natural Knowledge'* in their respective fields of specialization,—Radio & Space Physics and Algebraic Geometry. Their inclusion in the list of the galaxy of outstanding scientists also brings glory to the present status of Science in India for which they deserve our heartiest felicitations. ☐

M. K. Das Gupta

References : Year Books and the Biographical Memories of the Fellows of the Royal Society and the INSA and Science & culture.

NATURAL RESOURCES AND INTEGRATED RURAL DEVELOPMENT IN HIMALAYA

N. P. MELKANIA* AND UMA MELKANIA*

Forests and grasslands have a significant role in the functioning of the ecosystem in the Himalaya. In the present communication, the status of the natural resources and their significance in generating employment for the inhabitants are examined. People's participation in the developmental programmes like afforestation, etc., can solve the increasing problems of resource conservation, environmental hazards and outward migration.

THE Himalayan region constitutes a major part of a hilly land continuum whose meanings for human progress are undergoing a rapid change. This hilly continuum starts from Kashmir, Himachal Pradesh and eight hill districts of U. P. in west; Kingdom of Nepal in central; Sikkim, Darjeeling, Arunachal Pradesh and Protectorate of Bhutan in east to Assam, Nagaland, Manipur, Tripura and Meghalaya in North-eastern part of the sub-continent. There are communities like *Johari, Bhotia, Newar, Naga, Marchayas, Kumauni* and *Garhwali* (indigenous) and *Gujjars* and *Jads* (migrants) which serve the bridge role in this border region of the country. The paradox of the Himalaya is that it is endowed with

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* Department of Environmental Sciences, College of Basic Sciences & Humanities, G. B. Pant University of Agric. & Tech., Pantnagar-263 145, U.P., INDIA

immeasurable natural wealth in the form of forest products, variety of food grains and everflowing rivers like Alakhnanda, Bhagirathi, Yamuna, Mandakini, Pindar, Saryu, Ramganga and Kali. The density of population in this region is low compared to plains. The people living in these remote areas are among the poorest in the country. The present economy of the region is based primarily on money orders from migrants. The man power (educated and uneducated) is in surplus in the hills, to which the present level of agricultural technology is unable to absorb. As a result, they migrate out on long sojourns to the plains. This could be described as "skill drain" comparable to "brain drain" in the underdeveloped and developed countries. The migration of educated youth to plains not only influence the socio-economic conditions of the region but also weakens the border region of the country. The present communication is an attempt to elaborate the present state of natural wealth in the Western Himalaya and its possible role in generating employment for the surplus man power of the region.

Present status of natural resources

Forest stock and development Conflicts : About 53.2% of the land area is under a variety of forest covers which constitute about 24.61% of the total forest area of the country[1]. These woodlands not only provide raw material for direct use of inhabitants and industries but also maintain hydro-ecological cycle of the country. The forests are controlled by various agencies as given in Table 1.

TABLE 1

Classification of forests	Area (km^2)
Area under the control of Forest Department	23,770*
Civil & Soyam Forests	7,600
Panchayat Forests	2,450
Private, cantonment and municipal forests	230
	34,050**

*The area includes land under snow cover, alpine pastures, rocks and blanks.

**The actual area covered with forests is only 41% of this area.

(Source : Govt. of U. P. Hill Deptt., "Forest Development in the Hills of Uttar Pradesh", Status paper presented at the Seminar on Hill areas held at Nainital, April 1-4, 1980, organized by the Giri Institute of development Studies, Lucknow and Planning Commission, Government of India, New Delhi).

The growing stock of forests under the control of Forest Department in U. P. hills is estimated about 60 million m^3. The growing stock of civil, soyam and panchayat forests have not been assessed scientifically and are estimated to be 10% of areas assessed. The annual increment to forest stock is estimated at 0.78 million m^3. Considering the present state of exploitation, the carrying-capacity of these forests[2] would be over-reached by 2031. Further more, regeneration of the tree species of manifold significance like *Quercus leucotrichophora* is posing an alarming condition. According to the study conducted in Government house forests, Nainital[4], it was observed that the density of saplings recorded for *Q. leucotrichophora* and *Q. floribunda* was $5.5/100 m^2$ and $57.5/100 m^2$, respectively, whereas of the former species no seedlings were recorded. The pressing influence of biotic factors (lopping and cutting of trees, infestation of seeds by insects, pests and plant pathogens) together with abiotic threats (e.g., poor site conditions, etc.) aggravate the situation.

Recently, afforestation programmes have been conducted by the Government. But keeping in view these programmes, the gross annual incremental rate is assumed to remain at 0.78 million m^3/annum. The net annual depletion of forest stock thus amounts to 3.76 million m^3/annum, showing thereby the exploitation policies of the Government due to which the forest capital is being sweeped away[2]. The situation, therefore, needs people's participation for conservation and development of the forest stock.

The Government policies have a tendency to overlook the human aspects of forest development. The local people have been blamed a lot for the exploitation of these forests.

It is only in recent years that the ruthless destruction of forests have been done by greedy contractors for their own benefits and sometimes unwise programmes. Moreover, plantation of the coniferous and *Eucalyptus* species is another conflict among the planners and the inhabitants. The conflict of the choice of species is the real cause of the failure of a successful afforestation programme which curb the involvement of the local people in the development and management of the forests. It is desirable that the developmental strategy with respect to the conservation of natural resources should be such that the privileges of the forest dewllers not be taken away.

Potential and problems of grasslands: The grasslands in Himalaya, except those occurring in sub-alpine and alpine regions (meadows and *buggyals*) are seral in nature and are maintained by fire or grazing. These have arisen as a result of abandoned cultivation of deforestation[5], thus exhibit bio-edaphic climax. The productivity and quality of the indigenous fodder species are low compared to grasslands in other countries. There are wide variation in their production potentials probably due to varying management practices, topographic and altitudinal variations. In general, the production potential of mid-Himalayan grasslands ranges between 19.66 Q ha^{-1} (under poor soil substratum) to 30.32 Q ha^{-1} (under good soil substratum) on fresh weight basis[6]. The intensity of grazing has already crossed the carrying capacity of these grasslands[7,8]. The average yield level under partial protection during monsoon period is about 24.70 Q ha^{-1} which goes down to 7.20 Q ha^{-1} under continuous grazing[6].

Projected requirement and availability figures for fodder show that even at the present rate of grazing pressure, the carrying capacity of the civil/soyam/panchayat/community lands would be over reached shortly and an irreversible reaction will start[2]. Therefore, continuous grazing of these grasslands should be prevented immediately. A simple enclosure of the continuous grazed grounds atleast for five years will be effective in establishing the regeneration of the palatable grasses[6]. Such protected system could be used for **grazing later on, with a** partial enclosure during **July to October. Additionally,** the rotational **grazing will help in managing** the grazing fields.

The results of surveys conducted around Almora in the mid-Himalayan region indicated that there are about 56 species of grasses in the region[9] but only a few (*Heteropogon contortus*, 48.79%; *Chrysopogon fulvus* 9.09%; *Imperata arundinacea* 5.47%; *Eulalia trispicata* 3.97% and *Mnestithea laevis* 3.48%) contribute maximum to the production potential of these grasslands. Only a few grasses, viz., *Chrysopogon fulvus, Pennisetum flaccidum, P. orientale* and *Eulalia trispicata* are preferred to by animals; while species like *Cymbopogon distans, C. juarancusa, C. stracheyii, Ischeun albens* and *Eragrostiella nardoides*, reduce the palatability of the hay due to poor nutritive value[10]. *Heteropogon contortus* constitutes the major part of standing crop of these grasslands but is not palatable after flowering due to the development of spiny awns. Species of *Cymbopogon* are preferred to by cattle only during hot summer because the excessi
drying of their hay in open atmosphere toget sub
with leaching or volatilization of aromati ke it
stances during winter and spring months m th,
palatable, compared to its fresh-hay stage.

Besides germination vigour and grov
these grasses are influenced by several biolog is
agents. There are a number of shrubs and w l-
in the grasslands (e.g., *Anaphalis araneosa, A a,*
isia vulgaris, A. parviflora, Euphorbia angus ler
Crataegus cranulata, Berberis lycium, Tagetes he
and *salvia lanata*) which influence advers ed
growth of the grasses. It has been invest ce
that *Artemisia vulgaris* and *Salvia lanata* pr s
some water soluable phytotoxic substa
which inhibit the seed germination and seedl
growth of the associated grasses and other dico
angiosperms.

The existing forest cover also determines the structure of the forest floor vegetation[12]. In middle-Himalaya, the bulk of the forest is occupied by *Pinus roxburghii* which produce gr
a thick carpet of dried needles on the for
ground. This not only increase acidity in soi

also prevent light penetration, thus, deteriorates the quality and quantity of the light needed for germination of grass seeds. It was observed that all parts of *P. roxburghii* (i.e., young developing leaves, old mature leaves, leaf and wood litter and soil around the tree) inhibit the germination and ultimately the growth of selected harbaceous species[11, 12]. Therefore, rapid encroachment of such deleterious species over grasslands and other areas of broad-leaf vegetation must be managed properly.

Aquatic Ecosystems : Both the running (e.g. rivers) and stagnant water bodies (lakes and wetlands) are evident in the Himalaya. The lakes and wetlands represent the significant recreational resources of manifold significance. Compared to the rivers, the latter have been deteriorated extensively by glacial or man-made silt load and other anthropogenic activities[13]. The high altitude lakes are mostly oligotrophic and supported by snow-melt and precipitation, whereas the mid- and low-elevational lakes receive water from local drains and represent advanced stage of trophic evolution. These aquatic systems offer a variety of resources to local inhabitants, e.g., fishes as protein-rich food, crabs, aquatic weeds for animal fodder, etc. Due to extensive biotic pressure, these resources are becoming scarce. These systems, if managed scientifically, could be the source of local employment in the region.

Possibilities for Rural Employment

(a) Forestry—a tool for occupation: Himalaya is characterized by different types of forests and forest products[13, 14], even in the same district[15]. A number of small-scale industries, viz. tea cultivation, mushroom cultivation, apiculture, sericulture, medicinal and aromatic plants and other forest based industries (match industry and paper industry) are based on these forests. But the forests have so far played a very insignificant part in the development of the regional economy. Though the traditional forest rights of the people have been curbed in the name of forest-resource conservation, the planning of exploitation of the forest resources continues to be detrimental to the interests of the inhabitants. This has produced a sad reaction. Therefore, people's participation in preservation of the forest is becoming hard to achieve.

Life is difficult for lack of adequate and proper supplies of food, fuel, equipments and drinking water. Fifty to 80% labour days are wasted due to lack of adequate employment, and upland dry agriculture provides employment only for 126 days a year per worker[16]. Hence, immediate attention is needed to develop forestry based programmes in this region. This will not only develop awareness among people but also help tremendously in utilizing the surplus manpower of the region. The role of the forestry especially, social forestry in generating employment has been described elsewhere[17].

(b) Agroforestry concept: The Himalayan system covers an area of 7,78,878 km² and has a population of 58.42 million in 1981; leaving Nepal and Bhutan, the Himalaya in the Indian sub-continent comprise and area of 4,70,367 km² which forms 14.37% of the total area of the country and are inhabited by 42.96 million people, accounting for 6.28% of the population of the country. About 16% of the total reported area in Western Himalaya is under agriculture which serve the only existing source of employment in this region. The human population has increased for 3.82 million in 1971 to 4.78 million in 1981 at a compound rate of 2.28% per annum. According to 1971 census[18], 75.8% of the workers are engaged in agriculture, while the cultivated land for agricultural worker is only about 0.68 ha as against 0.83 ha state average.

The increasing agriculture has its own problems. Economic analysis of significant input-output parameters of agriculture in U.P. hills (Table 2) indicated that in five years of progressive agriculture between 1974-75 to 1978-79, a 3% increase in food production was accompanied by a 8.99% increase in agricultural land and 2.56% increase in the distribution of total fertilizer in the form of NPK[19, 20]. This shows a negative response of yield potential to the extra energy added as fertilizers and fossil fuels required for cultivation

TABLE 2 : Relationship among area, grain production and fertilizer input in Uttar Pradesh

Category	1974-75		1978-79		Difference	
	Hills	Total U.P.	Hills	Total U.P.	Hills	Total U.P.
Total area under food grains (ha)	862929 (4.63)	18653854	974494 (4.90)	19895375	111565 (8.99)	1241521
Total grain Production (m tons)	993759 (6.05)	16327799	1197228 (5.18)	23107728	203469 (3.00)	6779929
Fertilizer distribution (m tons)						
N	10047 (3.05)	329178	21201 (2.75)	772135	11154 (1.49)	750934
P	2293 (4.67)	49069	6832 (3.30)	206873	4539 (2.88)	157804
K	1997 (6.32)	31556	2936 (3.70)	79398	939 (1.96)	47842
Total	14337 (3.50)	409803	30969 (2.93)	1058406	16632 (2.56)	648603

Parentheses values denote per cent value that of the whole Uttar Pradesh.

and harvesting. Moreover, deforestation, expending agriculture and cultivation in unproductive marginal, steep slopy terrain without considering the land capability, are causing massive environmental degradation and deterioration of the land resources[21]. Unless properly terraced, the productivity of such lands will go down further and erosion hazards will increase.

The strategy for judicious land-use pattern in the hills should be productivity increases through agroforestry which will not only fulfil the requirements of food, fuel and shelter simultaneously but also provide employment to people. The agroforestry programme should aim at ·

(1) The selection of species according to the basic needs and choice of the inhabitants.

(2) The priority should be given to indigenous materials as they fulfil needs of the people and well acclematized for the hill environment. Some indigenous species suitable for agroforestry and silvipasture are listed in Table 3.

(3) The exotic species selected for planting must be studied scientifically for their deleterious effects, if any, on the existing vegetation and agricultural crops.

(4) Preference should be given to multilayered polyculture involving broad-leaf species of manifold significance.

(c) Watershed management : In Himalaya, the run-off from the land during monsoon causes deterioration of site-quality and soil-moisture deficit during dry periods. This together with faulty traditional methods or cropping on outward slopy terraces reduces the productivity of land. Watershed management programme in the Himalaya has a great potential for employment[22], thus, help significantly in uplifting the rural economy.

The erosion of land by the monsoonal floods can be prevented by making small earther "check tanks" of stones along the slope of rivulets and a large one at the base of it. The rain water can be collected in these reservoirs. This should be followed by plantation of water-conserving tree species, e.g., *Alnus nepalensis, Salix* spp., *Quercus leucotrichophora, Q. floribunda, Prunus puddum* and *Ficus religiosa* and control of grazing on the slopes along the water channels. The series of trenches along the contours of the slope of terrain will help in traping the silt and water, supporting a quick growth of trees and grasses. This will not only prevent the soil run-

TABLE 3 : Plant species suitable for agroforestry and development of grasslands in Himalaya

Species	Local name	Ecological zone	Utility
TREES			
Aesculus idica	Pangar	Dry trop-temp	Fw, Mc, M
Alnus nepalensis	Udis	Moist sub-trop-temp	Fw, Wm
_Bauhinia purpurea_*	Queral	Temp.	Fw, F, Flower, edible, M
_B. retusa_*	Kanol	Sub-trop	Fw, F.
Boehemeria rugulosa	Gethi	Sub-trop	Fw, F, Utensils
Castanea sativa	Sweet chestnut	Sub-trop-temp	Fw, Fr.
Corylus colurna	Kapasi	Temp-Sub alpine	Fr, M
_Emblica officinalis_*	Amla	Trop-Temp	Fr, M
Ficus macrophyll	Timil	Temp	Fw, F, Fr, M
_F. palmata_*	Beru	"	Fe, F, Fr
Grewia optiva	Bhimal	Sub-trop-temp	Fw, F, Fibre, Sc.
Malus sylvestris	Seb	Moist temp	Fr
_Melia azedarach_*	Batain	Moist trop-dry temp	Fw, F
_Morus serrata_*	Kimu	Sub-trop-temp	Fw, F, Farm implements
Ougenia oojenensis	Sanan	Sub-trop	T, Fw, F
Prunus persica	Aru	Temp	Fr
P. puddum	Paiya	"	Fw, F
Pyrus communis	Naspati	"	Fr
P. pashia**	Mehal	"	Fw
_Toona ciliata_*	Tuni	"	T, Fw, F (poor quality)
SHRUBS			
_Agave americana_*	Rambans	"	Fibre, Fe
_Berberis asiatica_*	Kilmora	Sub-trop-temp	Fw, F, Fr, M, Fe
_B. lycium_*	"	"	Fw, F, Fr, M, Fe
Crataegus cranulata	Ghingaru	Temp	Fr, Farm implement, Fe
Rubus ellipticus	Pila Hisalu	"	F, Fr, Fe
HERBS AND CLIMBERS			
Apluda mutica	Chhari-ghas	"	F
Arundinella nepalensis	-	"	F
Chrysopogon fulvus	Ghoria	"	F, Sc
Desmodium spp.	-	"	F
Eulalia trispicata	-	"	F
Mnesithea laevis	-	"	F
Pennisetum flaccidum	Bimalsiya	"	F, Sc
P. orientale	"	"	F, Sc
Saccharum sponteneum	Kush	Sub-trop-temp	Sc
Themeda anathera		Temp	F
Tinospora cordifolia***	Gurj	"	F, M

* Species reproduce vegetatively by coppicing.
** Species reproduce by root suckers.
*** Species could be propagated by stem-fargments.

Abbreviations : T—Timber; Fw—Fuel wood; F—Fodder; Fr—Fruits; M—Medicinal; Fe—Fencing; Sc—Soil conservation; Wm — Watershed management.

off but also save the agricultural land. Additionally, the reservoir will provide a water bank for the villagers. Because of this water share, cropping system, fodder and tree growing, every hectare of land will provide productive employment and revenue to the villagers.

(d) Animal husbandry and agrostology : Almost all the farm families have cattle for use as draft animals, goats and sheep for ritual sacrifice and wool, mule and horses for transport and bullocks to pull the ploughs for maintenance of agricultural lands[23]. Each farm family maintains 5-6 cattle units (one or two bullocks, a cow and/or a buffalo and 2-3 young ones for replacement) as livestock component. Additionally, a large number of goats and sheep are kept by some families in mid- and higher-Himalaya. The animals are dependent principally on natural fodder (fresh green grass and dried hay) and top feeds. About 80% of fodder requirement is met from pastures, fodder trees and forest ground vegetation. The animals are grazed on pastures and forest grazing lands during day hours and only night fodder is given to animals. The stall-feeding of cows is very rare. The farmers keep a large number of unproductive animals, primarily for dung, (an essential for hill agriculture) as manure. Thus, the animals are crucial link in the mountain ecosystem. They not only broaden the food-resource base of human being through their ability to digest and convert vegetal materials which humans cannot assimilate into forms they can assimilate[24], but also generate employment for people in the form of milk enterprise and animal enterprise. The animal husbandry needs:

(1) Improvement in the quality of domestic animals.

(2) Improvement in the fodder potentials of grasslands and community lands which can be achieved by (i) scientific management of grasslands with special attention on grazing capacity, palatability and nutritive value of grasses; (ii) introduction of suitable legumes and grasses; and (iii) planting fast growing fodder trees in community lands. Some suitable indigenous grass species for the development of grasslands are listed in Table 2.

(e) Farming of medicinal and aromatic plants : The hill region, at present, possesses agriculture and a trace of horticulture as the only base for rural industries. Medicinal and aromatic plants can play a dynamic role in improving the rural economy of this region. It is estimated that at present about 200 medicinal and aromatic herbs from Kumaon Himalaya are commercially collected from wild sources[25]. The regular supply of these herbs from their abode now needs conservation and management in a judicious scientific manner either by planned extraction (e.g., *Nardostachys jatamansi, Jurinea macrocephala, Skimmia laureola, Swertia chirayita,* etc.) or cultivation of economic species (e.g., *Picrorrhiza kurroa, Valeriana jatamansi, Hedychium spicatum, Acorus calamus* and *Punica granatum,* etc.) in different agroclimatic conditions. A proper incentive should be given to the farmers interested in cultivation of medicinal herbs. The farmers should be ensured about the proper disposal of their produce to get economic benefits.

(f) Pisciculture: Himalaya is the abode of many lotic and lentic water bodies which contain about more than 30 cold-stream fishes like Mahaseer (*Tor tor* and *T. putitora*), Asela (*Schizothorex* spp.) and *Unera* (*Labeo dero*). The inhabitants utilize leaves of some plants (*Agave americana, Yucca* spp., *Rhododendron arboreum, Juglans regia* and *Sapium insigne*) for catching fishes. This creates toxicity in these neat and uncontaminated abode for acquafauna[26]. In addition to this, the dynamiting in hill streams sweeps out the whole progeny (egg to adult) of fishes. The lakes and the wetlands are the source for tourism. The former also support the potable water demand of some districts in the region.

The results of investigations in lakes, wetlands and some hill streams indicated pollution and a decline in fish-fauna in the region[27,13] due to unprecedented upsurge in human population in the catchment areas, deforestation and faulty methods of fish catching. There is an urgent need to fish-polyculture in the region. Researches on cold-water fisheries, including induced breeding will be much helpful in meeting the requirement of protein-rich food.

The tanks developed along the slope of terrain for watershed management will provide the reservoirs for fish culture, thereby generate employment for the inhabitants.

(g) Regional scientific education: Jawahar Lal Nehru and Indira Gandhi had emphasised the necessity of inculcating a scientific culture and temper among the people for initiating the regional development, emphasis be laid on scientific education and spread of technical knowhow. No doubt, we have achieved a lot in different fields of research but the implementation of the technologies developed is not proper. Since most of the agricultural operations, in hills, are carried out by women, without proper knowledge of the modern technology, scientific use of biological resources and their conservation to the women it will not be possible to achieve a breakthrough in productivity and ultimately in the economy of the region. Therefore, some rural-education programmes should be formulated and suitable educated local people should be selected for this task which will make a sure success of the education programme even in regional languages. Additionally, this will also help in preventing outward migration of educated youth in search of employment.

The women power in Himalaya is neglected. At present, there is considerable wastage of women power by keeping them engaged in domestic chores. Hence, integrated efforts should be made to extend labour-saving devices in the region so that women could find more time to devote to other constructive activities like knitting and carpet industries, etc.

Conclusions

The Himalayan forests provide several biological resources of unconventional food plants, medicinal and aromatic plants and forest products. These forests cannot be protected unless problems of fuel and fodder are solved. There is an urgent need to formulate forestry-based plannings for the region which will not only fulfil the essential requirements but also offer employment to rural people, thus reverse the outward migration (seasonal, semi-permanent and permanent). There should be a conservational use of natural resources, keeping in view their danger of depletion and environmental degradation. The technology should be developed considering the needs and socio-economic constraints of the people. The proper policy for this region should be based on intermediate technology (judicious application of modern technology with old viable practices). It should aim at the utilization of local raw materials, local enterprises and local skills to the maximum which will encourage the local people for cultivation. Where enterpreneurship and skills are lacking, there should be a strategy of building up the same within a reasonable period of time. The land-utilization pattern should be based on a proper assessment of the products which can be grown easily in the agroclimatic conditions of Himalaya. The tourism should be extended according to the carrying capacity of the region. Before adapting any developmental programme (social or scientific), their adverse effects on the ecosystem must be taken into consideration.

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SOME CONJECTURES ON THE NATURE OF ENERGY AND MATTER

HASMUKH K. TANK*

1. Introduction

SOME of the most fundamental problems before current physics are :

(1) What is the fundamental theory of matter and how to reconcile gravitation with the other known interactions of matter;

(2) Why energy is quantized and how to grasp the deeper significance of the calculations, showing that the sum of rest-mass-energy and the gravitational potential energy of the whole universe is zero[1].

(3) Why quantum mechanics is probabilistic; and

(4) How various conservation-laws are interrelated.

As an attempt to seek solutions to these problems, some conjectures on the nature of vacuum, energy and matter are presented here.

The General Theory of Relativity describes gravitation as the curvature of space-time produced because of the presence of matter. Though this description is the most genius work to explain 'action at a distance' in geometric terms, it does not offer any mechanism for how exactly the presence of matter can cause the curvature. Albert Einstein intuitively strongly felt that there must be a way to unify gravitation and electro-magnetism in geometric terms, and

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he worked hard throughout his life to achieve this goal. According to his ultimate vision, which he never "proved" (demonstrated mathematically), "A piece of matter also is a curvature of space-time-continuum"[2]. Partly in tune with Einstein's vision, it is proposed here that a piece of matter actually may be a process of curvature fluctuations of space-time-continuum.

For the clarity of description first of all let us define a few terms.

2. Definitions of the Terms Used

2.1. *Space and Time:*

The first and foremost fact, which we have taken very much for granted, is that we are *conscious* of our surroundings. This fact is at the base of all sciences. Science is an attempt to organise and consistently describe our experiences. The main feature of our experiences is the ceaseless change in what we perceive.

To describe these subjective experiences of dynamic surroundings, we have non-verbally mutually agreed upon a—subjective, mental abstraction i.e. a concept of empty, non-moving 'space' and constantly running 'time'. 'Space' and 'time' are defined here, simply as the coordinates of our consciousness. They are not the entities of objective, physical world.

2.2. *Vacuum:*

The very fact that we have to attribute the properties like curvature and flatness to so called "space' in the General Theory of Relativity implies that the part of objective world, conventionally called "space" is not an absolute void or nothingless. Just as it is meaningless to talk about the size of "rabit's horn", so exactly it would be meaningless to talk about the curvature of "space" if the so-called "space" were really an absolute void.

To discriminate from the conventional notion of emptyness associated with "space", we shall be using a term 'vacuum' for the part of objective world where matter-particles and radiation are not present.

3. Postulates

3.1. **Vacuum is a super-flexible-continuum (SFC), extended up to infinity in all the directions. And, because of its super-flexibility, some part of it is continuously—vibrating or fluctuating with reference to its surrounding vacuum.**

(It will be obvious, after going through the next two sections that a part of vacuum, moving rectilinearly with a constant velocity is not a physically allowed possibility in the super-flexible-continuum. So the question raised by the Special Theory of Relativity, as how to discriminate a constantly moving medium from the steady medium, does not arise.)

3.2. The effects of fluctuations in vacuum are transmitted with a finite and constant velocity, c.

4. Units of Space and Time

(i) Time: A unit of time is an arbitrarily chosen unit.

(ii) Length: A unit of length can be derived as — "a distance travelled by fluctuations in vacuum in a unit time" i.e. c.

5. Possible Pattern of Vacuum—Fluctuations

We have postulated vacuum to be a super-flexible-continuum (SFC). So, when a small labeled volume 'A' of SFC moves in any direction, the volume of SFC behind 'A' will also have to move because SFC is continuum. This chain of displacements in SFC must complete a circle as shown in Fig. 1.

The maximum velocity of displacement of any labeled volume, about any axis can be equal to c. At this velocity there cannot be any further relative change in the positions of points near the centre because the effects get transmitted in all the radial directions with the same velocity c. Further relative change in the position of points is possible only if the labeled volume move about some other axis. This displacement, say, about Z axis, can turn to X and Y axes respectively, such that a labeled volume in SFC

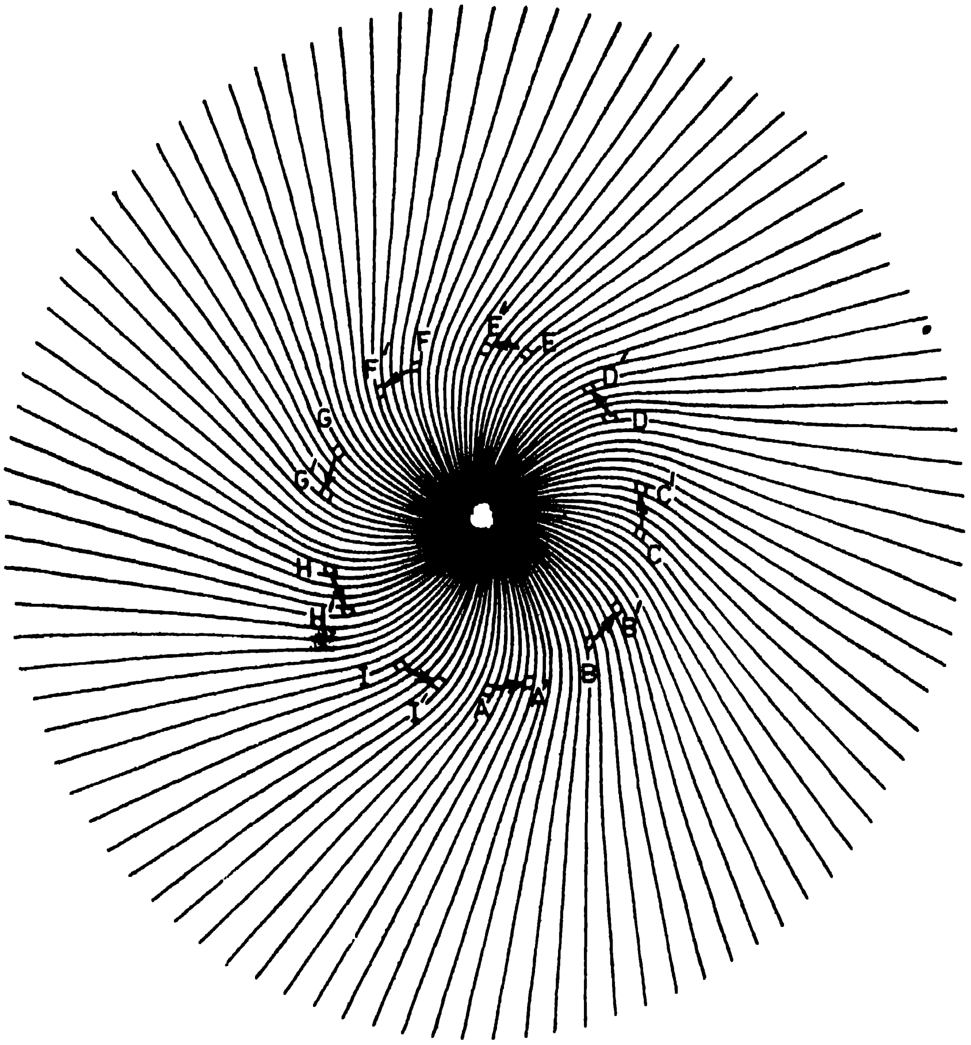
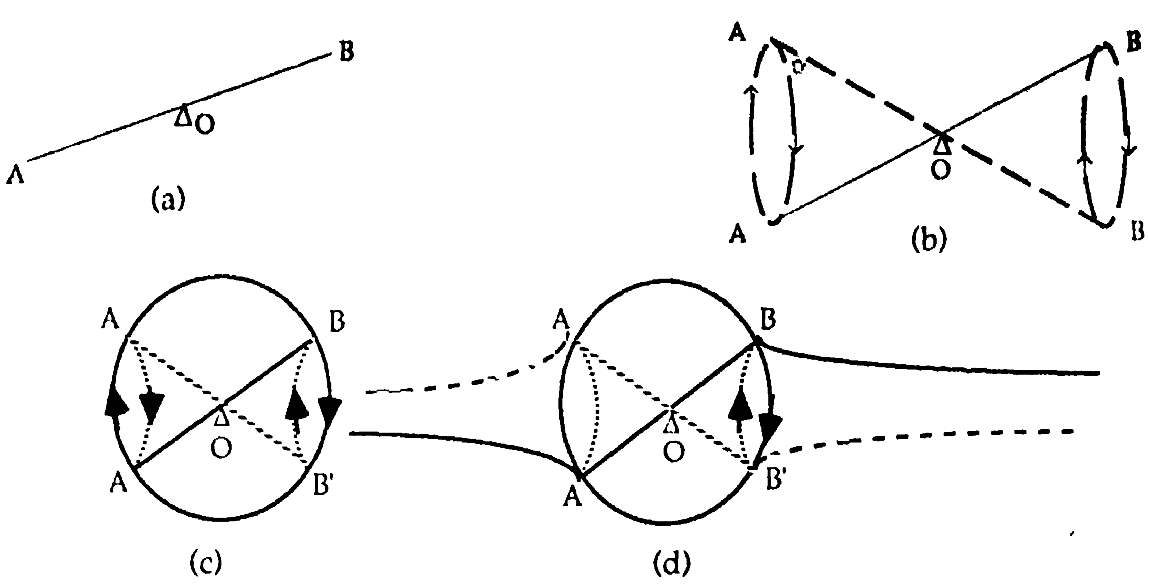


Fig. 1. When a small volume A in the continuum moves to A', all the other volumes I, H, G, F, E, D, C, B also shall move to new position—I', H', G', F', E', D', C', B' respectively.

forms a closed path on the surface of a sphere as described in the next paragraph.

First, let us imagine a rod AB fixed at its centre 'O' as shown in Fig. 2 (a). Now, imagine the above rod rotating, such that both of its ends A and B form circular paths. Portions OA and OB shall form cones because the rod is fixed at its centre 'O'. Please see the Fig. 2 (b). Next, let us imagine a spherical shell fixed to rod AB such that rod AB forms its diameter. When the rod AB rotates as shown in Fig. 2 (b), the whole spherical shell will also rotate about its all the three axes, and each and every marked point on its surface will form a circular path, as shown in Fig. 2 (c). Finally, let us imagine the above spherical shell as a part of super-flexible-continuum (SFC). When the spherical shell in SFC rotates as shown, the SFC in the neighbourhood of it also has to fluctuate, as shown in Fig. 2 (d). The effects of fluctuations in SFC will get transmitted along all radial directions. So these fluctuations will give rise to a spherically symmetric wave-packet as shown in Fig. 2 (e).

From the above discussion it is obvious that spherically symmetric wave-packet is the only possible pattern of sustained and localized fluctuations in vacuum-continuum. It means that there can be only integer number of such patterns of fluctuations in the vacuum-continuum. So called "particles" of matter and "quanta" of energy are actually the spherically-symmetric patterns of vaccum-vibrations as per the conjecture, presented here. It is because of the continuum nature of vacuum, that energy and



(a) (b) (c) (d)

Fig. 2 (a-d)

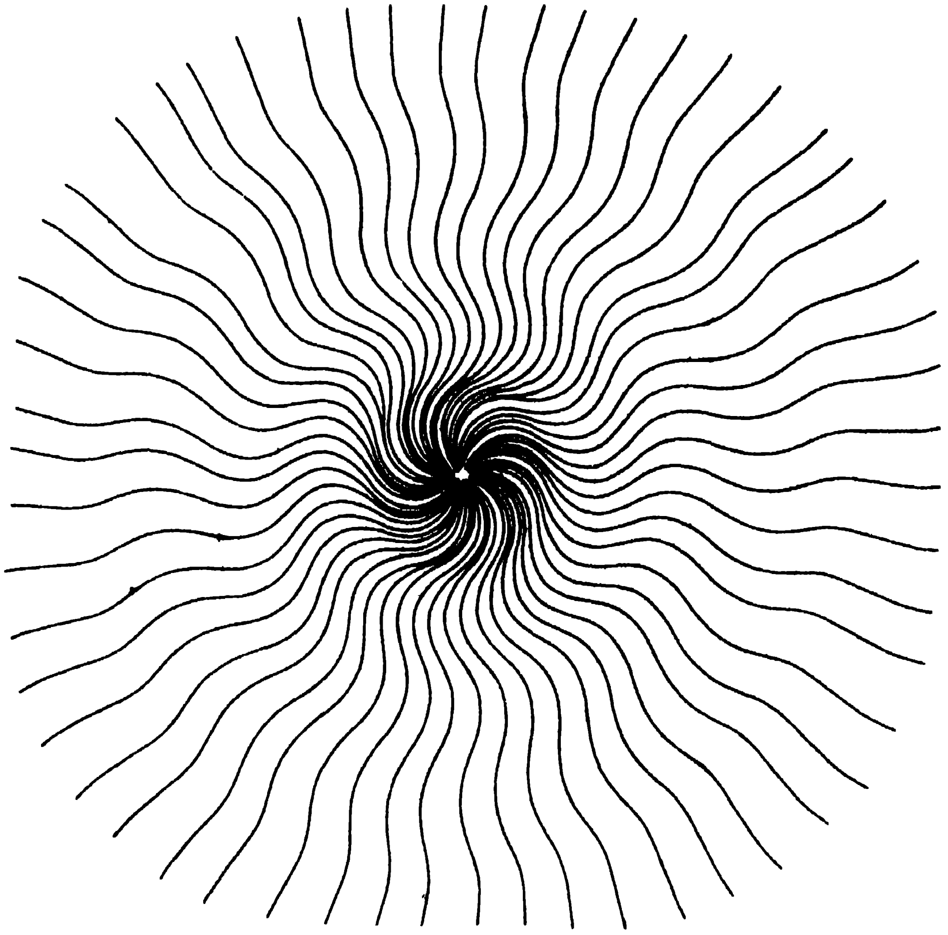
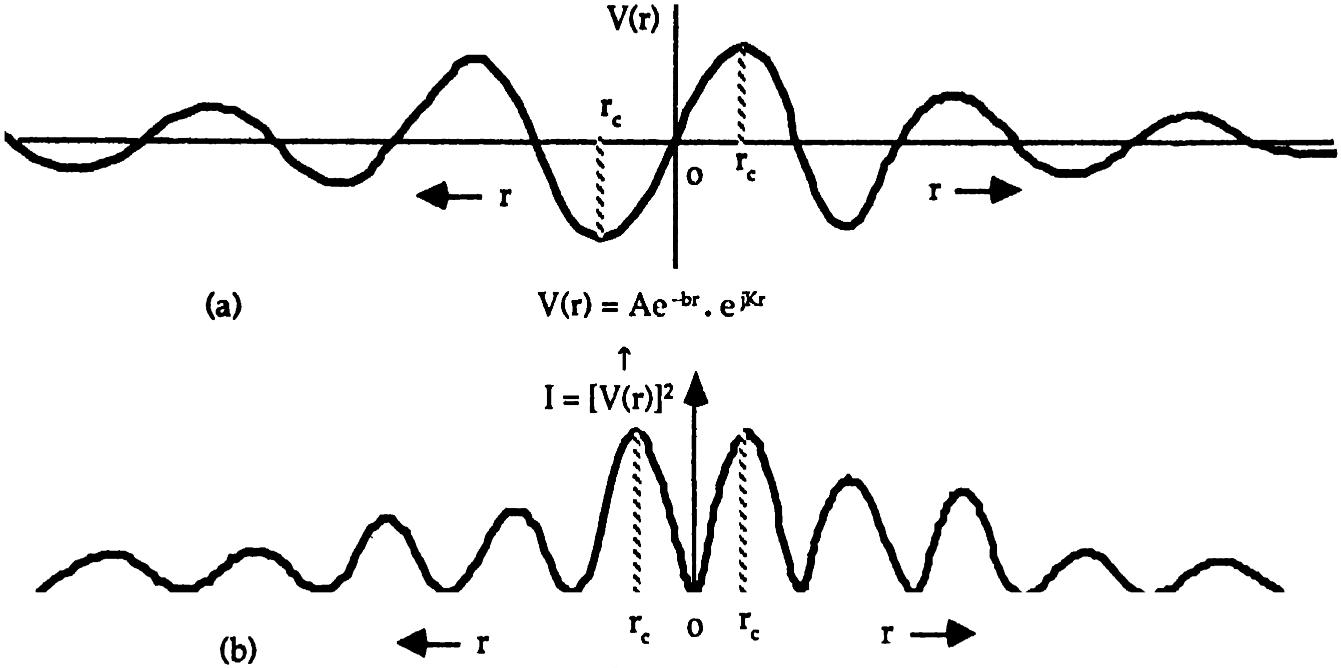


Fig. 2 (e). Spherically symmetric pattern of fluctuations, generated in a super-flexible continuum

matter are always found in the form of quanta called "photons" or grains called "particles".

The vacuum-fluctuations, forming a spherically symmetric pattern as shown in Fig. 2 (e) can be mathematically expressed as a function of space and time—$\Psi (x, t)$. And, at a given instant 't', the fluctuations of Fig. 2 (e) can be expressed as shown in Fig. 3.



$$V(r) = Ae^{-br}.e^{jKr}$$

$$\text{Total energy} = \int_{r=0}^{r=\infty}[Ae^{-br}.e^{jKr}]^2.dr$$

It is obvious that the above integral will converge to a definite value.

Fig. 3. One-dimentional representation of vacuum-fluctuations. V(r) represents the amplitude of fluctuation at a given instant (t) as a function of radial distance (r) from the centre

Please recall that among various solutions of Schrödinger equation, only the square-integrable function describes the physically realizable particle[3]. Where as a possible pattern of fluctuations in the vacuum-continuum has automatically yielded a square-integrable wave-function.

6. Some Gross Terms to Describe Vacuum-Fluctuations

The process of vacuum-fluctuations, forming a spherically symmetric patterns can also be described using the following terms :

6.1. *Field :* The vibrating part of vacuum can be termed as the 'field'.

6.2. *Field Intensity :* Field intensity can be defined as the 'intensity' of fluctuations at a given radial distance from the centre of the patterns, where 'intensity' means—

$$\begin{pmatrix}\text{The amplitude of fluctuations}\\ \text{at a given radial distance}\end{pmatrix} \cdot \begin{pmatrix}\text{The frequency}\\ \text{of fluctuations}\end{pmatrix}$$

6.3. *Charge* : There is something common among all the spherically symmetric patterns of vacuum-fluctuations, termed as 'charge'. 'Charge' describes the intensity of fluctuations at the surface of the spherical shell of radius r_c, where it is the maximum.

We have seen that any labelled dot on the surface of a spherical shell moves in a circular path. Secondly, the maximum velocity of motion of a labelled dot on the surface of spherical shell of radius r_c can be equal to c. So, either that dot can complete more number of circles of small diameter in a unit time, or it can complete less number of cycles of larger diameter. It means that the product—

$$2\pi \cdot \begin{pmatrix}\text{The amplitude of fluctuations}\\ \text{at the surface of radius } r_c\end{pmatrix} \cdot \begin{pmatrix}\text{The frequency}\\ \text{of fluctuations}\end{pmatrix} = c$$

$$\text{i.e. } 2\pi \cdot \begin{pmatrix}\text{The maximum field-intensity}\\ \text{of each and every pattern}\end{pmatrix} = c$$

It means that the maximum field-intensity of each and every spherically symmetric pattern is always the same. The radial distance at which the spherical shell fluctuates with the maximum intensity is termed as critical radial distance r_c. Of course, the direction of motion of a labelled dot on the spherical-shell of radius r_c can be either clockwise or anti-clockwise. i.e. 'charge' can be either positive or negative, but its magnitude is always the same.

For each fluctuation-pattern, there can be its anti-pattern also, fluctuating with the same frequency but having opposite charge, as if it moves back-wards in time.

6.4. *Energy*: Energy is a lump-sum description of fluctuations in a given fluctuation-pattern. Amount of energy depends on—

$$\left(\begin{array}{c}\text{Magnitude of}\\ \text{fluctuations}\end{array}\right) \cdot \left(\begin{array}{l}\text{Area of the shell x}\\ \text{its thickness which}\\ \text{vibrates with that}\\ \text{amplitude}\end{array}\right) \cdot \left(\begin{array}{c}\text{The frequency}\\ \text{of fluctuations}\end{array}\right)$$

[Please see the Fig. 3 (a) and (b)]

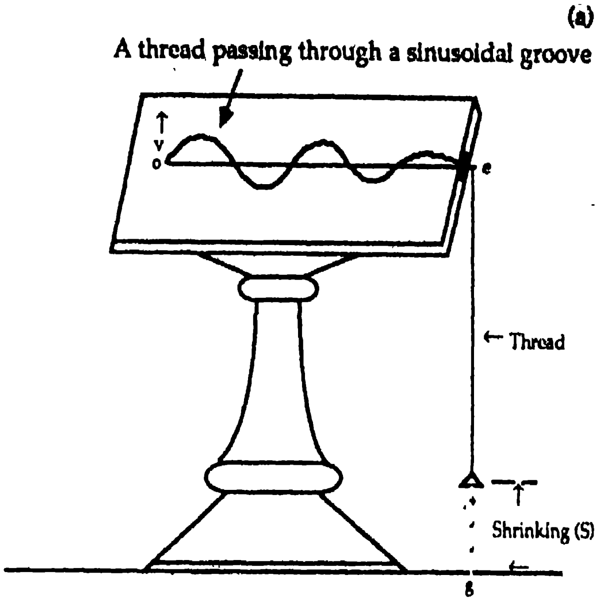
6.5. *Gravitational Field Intensity*: The intensity of gravitational field is a measure of shrinking of vacuum, produced because of fluctuations at a given radial distance from the centre of a fluctuation-pattern. [Please see the Fig. 4(a) to (d)].

6.6. *Mass*: Mass is a lump-sum description of the total amount of shrinking or amassing of vacuum produced because of fluctuations, by a given fluctuation-pattern. (Please see the Fig. 4).

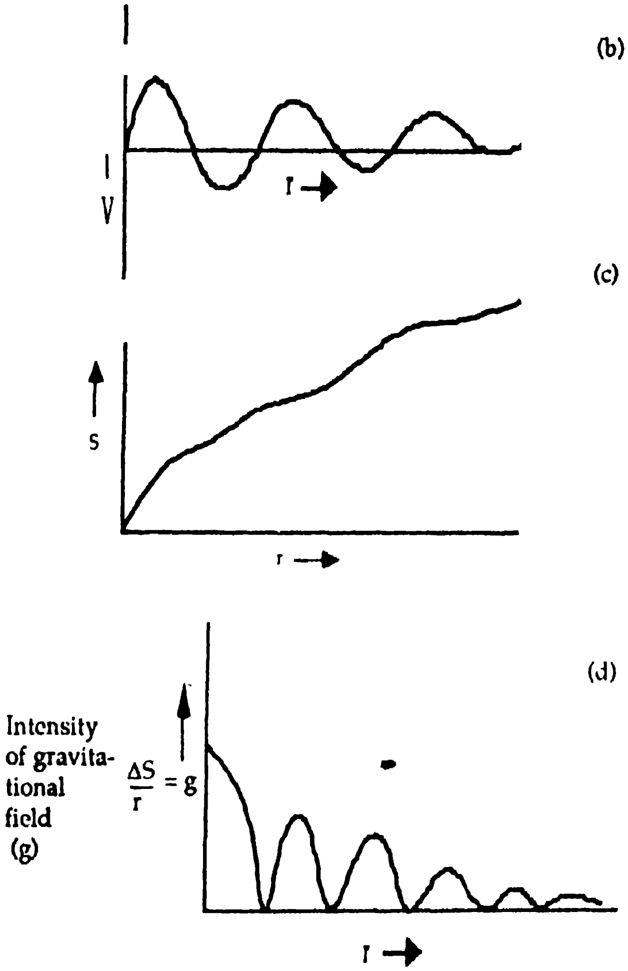
7. Interpretation of Some Observed Facts

7.1. *A moving "particle" and de Broglie's waves:*

A 'particle' is a spherically symmetric wave-packet of vacuum fluctuations. And, a moving particle is a drifting fluctuation-pattern. We have postulated that fluctuations in SFC are transmitted with a finite and constant velocity, c. So, when a fluctuation-pattern drifts in any direction, the wavelength of fluctuations, in front of the moving pattern shall reduce, similar to Doppler's shift. Relativistic contraction of length of a moving body and the "space-time" ahead of it seems to be because of the reduction in wave length.



Thread o, e, g, when passed through a sinusoidal groove shrinks by the length (S)



$$\text{Mass (m)} = \int_{r=0}^{r=\infty} g(r)\,.\,dr$$

Fig. 4 (a-d)

Secondly, when a spherically symmetric wave-packet of vacuum-fluctuations drifts in any direction, the phase of vibrations at a perticular point in space will experience the change. The wavelength of de Broglie's matter wave is the length at which the change in original phase due to the motion of pattern becomes 2π, i.e. de Broglie wave length $= 2\pi c/f_o \Delta\omega$. Interference of two such de Broglie's waves will mutually cause 'jerks' in the place of emergence of spherical fluctuation-patterns. By 'jerks' we mean that the places of emergence of spherically-symmetric patterns will shuttle back and forth in addition to their continuous drifting in a given direction, e.g. the frequency of fluctuation-pattern called 'electron' is $m_e c^2/h = 1.2356 \times 10^{20}$ cycles per second. When two such patterns move along some direction with a small velocity, the place of emergence of the patterns called 'electrons' will keep on shuttling within their de Broglie's wave-length, once in every $10^{-20}/1.2356$ second. The exact knowledge of the place of emergence of a given pattern would also require the knowledge of the phases of both the fluctuation-patterns at a perticular time. Without this phase-information we can only predict the probability of emergence of a pattern at a given place-time.

Even a single fluctuation-patterns, when it passes through two, nearby narrow slits, will also interfere because the other side of doubles slits will behave as two independent sources of fluctuations.

7.2. *'Particle' interactions:*

As shown in Fig. 5, when more than one fluctuation-patterns come closer to each-other, the amplitudes of approaching fluctuation-patterns get mutually added. But this addition cannot be linear because vacuum is postulated to be continuum. Any perticular labelled dot in a continuum is not free to move in isolation from its neighbouring points. At very close distances the total of amplitudes of two fluctuation-patterns will also be equal to the amplitudes of individual patterns. The interactions of fluctuation-patterns in a super-flexible-continuum will exhibit two important features.

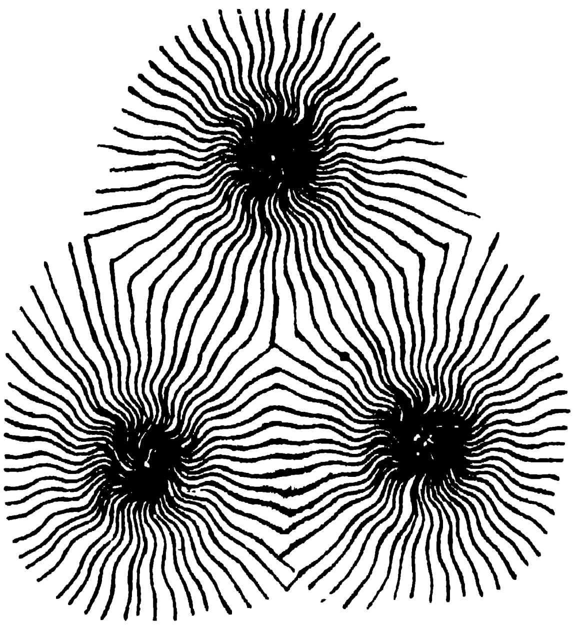


Fig. 5 Three fluctuation-patterns in a close vicinity

(i) When the phases of fluctuations of two patterns are such, that their amplitudes add constructively, then the patterns keep emerging at closer and closer distances. But, even when both the patterns come very close, then also the total intensity will not become double, but they will follow the mathematics, 1 + 1 = 1 i.e. the fluctuation-amplitudes add non-linearly in a continuum.

(ii) When the phases of fluctuations of two nearby patterns are opposite, then also, vacuum will not stop fluctuating; because it is postulated to be super-flexible. In such situations, both the patterns will keep emerging at farther and farther distances.

(a) Quantum Field Theories like QED accept the reality of fields only. In this theory, particle-interactions are described as non-linear super-positions of field-intensities. The non-linearity of super-positions, which is the most important feature of the theory to explain creation and annihilation of particles, clearly show that quantum fields manifest the characteristic which is akin to the fluctuations generated in a continuum.

(b) In the string theories, particles are treated as parametric excitations, similar to those induced in a vibrating string when its tension is increased. Various kinds of particle-interactions corrospond to different modes of vibrations, of that string. In these theories, gravitation corrospond to the lowest frequency of vibrations. String theories are quite successful because a string is a one-dimensional-continuum, which is the simplest version of the actual process going on in the three-dimentional continuum. The success of string theories implies that particles of matter may indeed be a process of vibrations, generated in a three-dimentional super-flexible-continuum.

(c) *Nature of Mathematical Expressions for Multiple-pattern-interactions*: We know that even the un-even bending of one-dimentional wire in Y-dimention as shown in Fig. 6, require N mutually orthogonal functions of space to mathematically describe it. So the modes of vibrations generated in a three-dimentional-continuum will obviously require 3 N mutually orthogonal functions of complex-vector-space and time. It means that the physical theory like quantum-machines, describing a physical Process called particle-interactions using the language of N-dimentional complex-vector-space and time may be actually describing a process of vibrations, taken place in a three-dimentional-continuum.

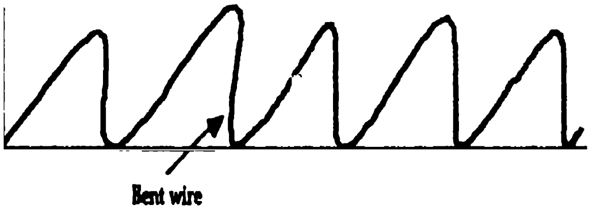


Fig. 6. Bending of one dimentional wire in Y-dimention would also require many mutually orthogonal harmonic functions of x to mathematically describe it

7.3. *Some insight into the conservation-laws :*

We have postulated that vacuum is super-flexible. So the total amount of fluctuations in a given system of fluctuation-patterns will remain the same even after their mutual interactions and formation of different kind of patterns. As per our definition, the 'energy' of a given system of fluctuation-patterns is conserved because of the super-flexibility of the vacuum-continuum.

We have also seen that the vibrations in vacuum are bound to be of circular and cyclic nature. This circular and cyclic nature of fluctuations is not altered even when mutual interactions of a set of patterns result in new patterns of different size and frequencies. So, as per our definition, the total angular-momentum is not altered in a given system of fluctuation patterns.

8. Conclusion

Space and time-dependence of 'matter-particles'; non-linearity of the equations in QED; the success of string-theories as well as various conservation-laws seem to support the conjecture that—(i) vacuum may be a super-flexible-continuum (SFC) and (ii) Energy and matter could be just a phenomenon or process called 'vacuum-fluctuations'. □

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Notes and news

Frontiers of Research in Musical Acoustics and Allied Signal Processing

An interesting Seminar on the above mentioned topic was held from November 26-28, 1987 at the Max Mueller Bhavan. The Seminar was organised by the Sangeet Research Academy's Scientific Research Department (SRA). The activities of the SRA in the field of Classical music is well-known, but the existence of a Research Department working on the various aspects of musical acoustics is not known to many. The Research Department was started about seven years ago and has developed a small group of scientists and engineers who are actively engaged in discovering the scientific basis of music—what it is, what are the traits of a sound that appear pleasing and musical. They are striving to understand this by analysing (a) vocal sounds (b) sound emanating from musical instruments. They are also studying the construction of these instruments. With a view to find out better substitute of the material for improvement of quality and economy.

In introducing the Seminar, Smt. Dipali Nag, Research Co-ordinator of the SRA said that the subject musical acoustics is however recent and interdisciplinary. It embraces physics, Psychology, Physiology, Neurology, Architecture, Phonetics and Linguistics. Processing of audiosignals (music, speech etc.) is one of the most fascinating areas of research today, both as an analytical investigation into human abilities and as an emerging engineering discipline.

The purpose of the Seminar as indicated by her was to promote a closer relationship between the field of acoustics of music and allied subjects by reviewing the state of knowledge in these areas and by exposing important issues and highlighting unsolved problems.

Prof. B. D. Nagchaudhuri delivered the Inaugural address and said that Sangeet Research Academy dedicates the Scientific Seminar to Sir C. V. Raman—a pioneer in the research in music in our country.

He traced the history of music from neolithic time and said that the earliest mention of music was not by any name but in rituals. Further he mentioned about the numerical relationship between notes mentioned by Pythagoras, and how by the end of 12th Century music had became a part of Church music. From thereon he went on to trace the history of research in music, in instruments which started about hundred years back as mentioned by Helmholtz and others.

(1) Prof. Santimay Chatterjee of Asiatic Society in his talk entitled "History of scientific research in Indian music" mentioned the works of Sir William Jones on Indian Classical music. He also spoke on the difference between Indian and Western Classical music in their structure and shape. The work of Sir C. V. Raman was also highlighted.

(2) Prof. S. S. Agrawal, a Research Scientist in the Central Electronics Engineering Research Institute, New Delhi, in his talk entitled "Communicating with machines by voice", highlighted the ties and the relationships between speech and music, the two natural means of human communication through sounds waves. Research on speech analysis, synthesis and recognition has helped in developing man-machine communication systems, voice and inferences drawn from these areas are helping in high quality research on music. In his talk he also discussed several areas of scientific research in music collaboration with research in speech.

(3) Prof. Premlata Sharma, an eminent musicologist and Vice-Chancellor of Indira Kala Sangeet Viswavidyalaya, Khairagarh (M.P.) in her paper entitled "A Historical overview of some aspects of Research in Indian Music", mentioned Bharata's Natyashastra and the relationships between notes, concepts of grammar,

the two Gramas—Shadaj and madhyam etc. Her contention that murchana, muquam and modes are of the same concept was of particular interest.

(4) Prof. B. S. Ramakrishna an eminent Physicist and former Vice-Chancellor of Hyderabad University, in his talk entitled "What makes a good concert hall", mentioned the basic problems of creating good acoustics in a music hall. In indentifying the physical features of the hall for producing good acoustics he referred to four points:

(a) absence of disturbing noises,
(b) adequate loudness of musical sounds,
(c) correct reverberation and
(d) early reflection of sounds from sidewalls.

He described in his talk the qualities of an auditorium for Indian classical music.

(5) Prof. A. K. Majumdar, Reader, Department of Electronics and Telecommunication Engineering, Jadavpur University in his talk entitled "Musical aspects of respiratory phenomena", said the respiratory system was the main power source for producing all speech and musical sounds. Breathing activity can be measured by its vital capacity and its pattern will be depended upon the contraction and relaxation of the muscles. He spoke about the three types of muscles which are responsible to generate musical sounds, i.e., intercostal muscles, diaphragm muscles and obligue abdominal muscles. The resultant effect of muscle control and the subglottal pressure is the main agent to produce loudness of phonation.

(6) Dr. A. Roy an eminent E. N. T. Specialist in Calcutta in his talk entitled "A technique of voice preservation", referred to the healthy functioning of all the vocal systems for smooth voice production. He mentioned the different problems which affect good voice production thereby laying ample stress on the crico-thyroid muscles and larynx.

(7) The psychological correlates of intensity and pitch were the main subject matter of the talk entitled, "On some psychological considerations in perception of of speech and music" by Prof. A. K. Dutta of Electronics and Communication Science Unit, Indian Statistical Institute. He discussed in detail the dependence of loudness on intensity, frequency and duration in the light of psycho-physical and psycho-physiological constraints. The phenomenon of masking, lateral inhibition etc. were introduced for an understanding of speech and music.

(8) Prof. B. M. Banerjee, Senior Scientist in the Sangeet Research Academy in his talk entitled, "The twin drums —Tabla and Bayan—and their sounds", reproduced the experimental findings of the exhaustive work done on the Tabla and Bayan as played by the expert tabalias of the SRA. He showed the spectral behaviour of the eleven basic strokes played by them. New information (to add to what Sir C. V. Raman published in 1920 and 1934) discussed by Prof. Banerjee were:

(a) The Bayan strokes generate very closely harmonic overtones; (b) The fundamental is absent in strokes 'Naa' and 'Taa', which have complementary acoustic characteristics; (c) In harmonics, though small, are often generated in strokes 'Toon' and 'Thoon'.

(9) Physiology and Physics of production of nasal sounds were discussed by Prof. A. K. Dutta of Electronics and Communication Science Unit, Indian Statistical Institute, in his talk entitled "Nasal Sounds". The spectrographic cues for perception of these sounds were discussed by him both for manner and place discrimination. In this context, he mentioned some work done in the SRA.

(10) In his talk entitled "Brain Mechanisms of speech and music", Prof. T. Desiraju of National Institute of Mental Health and Neuro Sciences, Bangalore, highlighted the scientific aspects of higher cerebral functions characteristic of the human brain, relevant to acoustic and musical attainment. According to him the great process of aesthetic expansion of functions the human brain utilises not only the speech mechanisms of neuronal net-work of the left cerebral hemisphere, but also perhaps more particularly the right cerebral hemisphere, and probably above all the pre-frontal cerebral cortices, as well as the highest processess of the limbic system, in an integrated manner to make available the peak experiences that are associated with great music.

(11) Prof. D. Dutta Majumdar of Electronics and Communication Science Unit, Indian Statistical Institute, in his talk dealt in detail with the status and frontiers of research in Musical Acoustics, signal procession and the related brain mechanism. He tried to establish a theory that speech and music constitute a mirror of the mind, and unless we acquire an understanding of the deep structure related to the states of mind, we cannot understand the cue for the innate musical skills. He also dealt with the aspects of musical skills and their relationship with the two hemispheric functions of the brain. ☐

Ranjan Sengupta

XIV International Botanical Congress

The First International Botanical Congress (IBC) in Paris (1867) had been succeeded in Paris (1900), Vienna (1905), Brussels (1910), Cambridge (1930), Amsterdam (1935), Stockholm (1950), Paris (1954), Montreal (1959), Edinburgh (1964), Seattle (1969), Leningrad (1975), Sydney (1981) and Berlin (1987). The next IBC will commence in Tokyo (1993). In the present Congress in Berlin (July 24 to August 1, 1987), there were about 2,500 contributions. Almost two-fifths refer to poster presentations and the remainder to symposium papers (1500) and general lectures (25). There were seven programme divisions, e.g. Metabolic Botany, Developmental Botany, Genetics and Plant Breeding, Structural Botany, Systematics and Evolutionary Botany, Environmental Botany and General Symposium —History of Botany.

Six botanists from West Bengal namely, D. N. De (Kharagpur), M. P. Nayar (Botanical Survey), G. Panigrahi (Botanical Survey), Malabika Roy (Viswa-Bharati), S. K. Chatterjee (Directorate of Medicinal Plants, W. B.) and the author participated in this Congress. A comprehensive report is presented here for the benefit of those could not attend the congress.

Taxonomy of plants needs a stable nomenclature but not at the cost of the principle of priority or the type method. Nomenclature section of the Berlin Congress was occupied mainly by the botanists (agriculturists, horticulturists, silviculturists, etc.) who were not interested in the technicalities and "sophisms" of nomenclature. Evidently, after the Berlin congress not only the specific names of economic plants but also the other specific names which are provided by Art. 69 may also be conserved under Art.. 14. Actually, a crack was opened at Sydney when conservation of specific names was allowed for the economic plants and that a number of participants persistently tried to drive in a wedge and open the crack ever wider. After three successive pollings they could not secure necessary votes on the appointed date. Last of all, on the early hours (8-30 AM) of the closing date, they managed necessary votes again through a 'tricky amendment'. The conservation of the specific names will not accelerate taxonomic studies and I am sure too much cunningness will over-reach the science of taxonomy itself. I do not feel that the conditions behind the wisdom of the nomenclature sections of earlier congress in rejecting the idea of conserved species names have changed. However, the Berlin congress sanctioned the conservation of the specific name *Lycopersicon esculentum* Mill. (Solanaceae) and proposed the rejection of the specific name, *Solanum indicum* Linn. (nom. legit. *Solanum ferox* L.) for the future. It is also approved that the official publication of the code would be a uni-lingual one and the Berlin code will appear in English only.

Regarding the gland physiology; Fahn, Heslop-Harrison and others described their findings. We may distinguish the members of Indian Droseraceae and Lentibulariaceae on the basis of their gland structures. Feeny, Berenbaum and others described coevolution and swallotail butterflies (Papillonidae). The Indian

Tros aristolochae Febricius exploits exotic *Aristolochia* spp. containing similar compounds. As to parasitic higher plants, Visser, Kuijt, Meijer, Fineran, Calvin, Okonkwo and Lyshede, presented their ideas. The parasitism of *Cuscuta* is not uneven. The *Cuscuta* grows in any kind of aquatic or terrestrial angiospermous hosts, but its haustoria disorganise at the post-penetration stage in some resistant hosts like *Euphorbia, Ipomoea, Pedilanthus, Phyllanthus, Trianthema* or partial resistant hosts like *Agave, Ficus, Polyalthia* or *Sonchus.* Xylary (vassel) continuity between the host and the parasite exists in Indian dodders (*Cuscuta reflexa* Roxb.) and mistletoes (*Viscum monoicum* Roxb.). Lyshede demonstrated the root anatomy of *Cuscuta* in the Preparasitic seedling stage. Dobbins interpreted included phloem in wider sense and his interpretation in the foraminate wood differs from that of Philipson and ward. Bischler, Koponen and others stated that the type materials of the Indian liverworts were not available on loan and this problem should be solved at all costs. Parris, Uffelen, Iwatsuki, Hennipman, Price and Walker expressed their views on the classification of Leptosporangiate ferns and a number of specific names previously determined by Pichisermolli have been reduced to synonyms. On the chemosystematics of pteridophytes, Murakami, Werth, Khandelwal and others presented their papers. Khandelwal described two new oil-yielding *Ophioglossum* and discovered the lowest chromosome number 2n = 32 in some Indian *Ophioglossum*. Panigrahi presented his excellent work on Indian Rosaceae. Arthur Cronquist admitted his findings on the nomenclature and distribution of the genus *Rosa*. His work on Indian Isoetaceae, Selaginellaceae and other Indian ferns were also appreciated in the Berlin Congress. Armen Takhtajan described the origin and the distribution of angiosperms for the different floristic regions of the world. Gudrud Dahlgren described the classification of Dicotyledons. The present Dahlgren classification differs from the preceding one. They broadly accepted nine larger groups i.e. Magnolioides. Ranunculoides, Caryophylloides, Polygono-Plumbaginoides, Rosoides (incl. Droseraceous and Amentiferous families), Dillenioides (incl. Euphorbiales, Urticales, Rhamnales, Tropaeolales, Salvadorales), Asteroides (incl. Balanophorales, Santalales, Araliales, Campanulales), Boraginoides and Lamioides (incl. Ericales, Fouquieriales, Sarraceniales, Loasales, Stylidiales). Kubitzki pointed out that the monocotyledoneae and the dicotyledoneae are artificial groups in the pleophyletic grade angiosperms. Dickison emphasized the importance of stem anatomy on the natural system of the dicotyledons and appreciated the works of B. G. L. Swamy on Xylotomy. Frijs described "The role of Martin Vahl—a Linnaean with visions of modern taxonomic ideas." Vahl's work on the taxonomy of the genus *Utricularia* foreshows the idea of a modern revision or monograph. P. K. Bhattacharyya presented his paper entitled, "Beginning of modern botany in India by the Dutch in the 16th-18h Century". W. T. Stearn, Stafleu, Wijnands, Nicolson, McNeill, Lack, Robson and Heywood accepted it. It is also appreciated that the first botanic garden was established in the Malabar by the Dutch and the Shibpur botanic garden preceded the Saharanpur botanic garden though Heywood (1983) cited a contradictory report. J. McNeill, (who is a decendent of the School of Hope, Roxbourgh, Balfour, Buchanan—Hamilton, Ritchie, Prain, W. W. Smith, K. P. Biswas, H. L. Chakraborty, S. K. Mukerjee and B. M. Johri) has been appointed the Director of the Royal Botanic Garden, Edinburgh, Scotland, U. K. Sundara Rajan (Bangalore) highlighted the botanical studies of the ancient Indians as described in Vedas, *Vrkshayurveda* of Parasara and *Amarakosa*. P. C. Silva depicted, "Napoleon Bonapartes' contribution to Botany, especially Phycology".

The author visited Berlin (B) and Copenhagen (C) herbaria and museums. To demonstrate the submerged aquatic plants, the establishment of the large aquarium (artificial tank with transparent sides) in the Indian Botanic Garden and the National Botanic Garden are recommended herewith. To demonstrate the root parasitic, saprophytic and insectivorous plants, special arrangements should be made in the Botanical Survey of India. Herbarium materials of Koening (1728-1757), Rottler (1749-1836), Wallich (1786-1854) and Voigt (1798-1843) are well preserved in Copenhagen (C). Large number of these specimens are the type of Indian plants. We must explore this opportunity in the near future. Photograph of all type materials of Indian *Utricularia,* along with the manuscript (Xerox copy) of M. Vahl's Enumeratio (1804), are now available in Burdwan (BURD) for consultation.

The Congress charged a hefty registration fee (Rs. 4600/- per person) which covered the cost of participation as well as the cost of abstract. There was musical entertainment at the opening of the congress. The participants were treated to drinks and snacks during the opening and closing ceremony. While such entertainments were available free of cost, Xerox and transport facilities were not provided to the delegates. Normally, these are covered by the registration fee in any meeting held at the international level. □

P. K. Bhattacharyya

Institution of Chemists (India) : Associateship Examination, 1989

The Thirty-ninth Associateship Examination of the Institution of Chemists (India) will be held in November. The last date for Registration is 30th November, 1988. The Examination in Applied Analytical Chemistry is divided into the following eleven sections and each candidate will be examined in two of them according to his choice as approved by the Council, in addition to General Chemistry including Organic, Inorganic, Physical and Applied Analytical Chemistry — (1) Analysis of Minerals, Silicates, Ores and Alloys; (2) Analysis of Drugs and Pharmaceuticals; (3) Analysis of Foods; (4) Analysis of Water and Sewage; (5) Biochemical Analysis; (6) Analysis of Oils, Fats and Soaps; (7) Fuel and Gas Analysis, (8) Analysis of Soils and Fertilisers; (9) Analysis Connected with Forensic Chemistry; (10) Analysis connected with Leather Chemistry; (11) Analysis Connected with Textile Chemistry. The Examination is recognised by the Government of India as equivalent to M. Sc. in Chemistry for purposes of recruitment of Chemists. Further enquiries regarding this and for Membership may be made to the Honorary Secretary, Institution of Chemists (India), 11/4 Dr. Biresh Guha Road, Calcutta-700 017. □

SCIENCE CORNER

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SEXUAL ISOLATION IN *DROSOPHILA*

B. N. SINGH**

Isolation is an indispensable factor in the origin and maintenance of race and species. Sexual or ethological isolation, a barrier to random mating due to behavioural incompatibilities, constitutes the largest and most important class of reproductive isolation in animals. The phenomenon of ethological isolation is widespread in the genus *Drosophila*, commonly known as fruit fly. The pattern of mating and the degree of sexual isolation have often been used to elucidate the direction of evolution among closely related species.

ISOLATION may be defined as the prevention of gene flow between Mendelian populations. Even Lamarck and Darwin recognized the importance of isolation in evolution. It has been suggested that the formation of races and species without isolation is impossible. It was Th. Dobzhansky of Columbia University, New York, USA who coined the term "isolating mechanisms" as a generic name for all such agents which prevent gene exchange between populations. If reproductive isolating mechanisms do not operate, the genetic differences which are pre-requisite for speciation and acquired through natural selection and genetic drift, will be swamped and speciation is not possible. Species of sexually reproducing organisms are genetically closed systems, because there is no gene exchange between them due to genetically conditioned barriers. According to Ernst Mayr of Harvard University, USA, the isolating mechanisms are the most important attributes a species has. Gene exchange between *allopatric populations* (those populations which are inhabiting different geographical areas) is prevented because individuals do not get a chance to mate. This constitutes geographical isolation. Such populations may or may not show reproductive isolation if brought together under laboratory conditions. On the other hand, *sympatric populations* (inhabiting the same geographical area) can be maintained as distinct units only if interbreeding is presented by barriers which constitute reproductive isolating mechanisms.

There are different factors which operate as reproductive isolating mechanisms between Mendelian populations. One or more mechanisms in combination serve to prevent gene exchange between separate Mendelian populations. Various authors have discussed and classified the kinds of reproductive isolating mechanisms.

Kinds of reproductive isolating mechanisms:

(i) *Seasonal isolation*—The individuals are sexually functional at different times.

(ii) *Ecological isolation*—Individuals of populations are restricted to different habitats of the same area by biological needs.

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(iii) *Mechanical isolation*—There is physical incompatibility between the sexual parts.

(iv) *Sexual or ethological isolation*—Lack of mutual attraction between males and females of different species due to behavioural incompatibilities.

(v) *Gametic isolation*— Sperm of one species are not attracted to the eggs or poorly viable in the genital tracts of another species.

(vi) *Hybrid inviability*—F_1 hybrid zygotes are produced, but they are inviable.

(vii) *Hybrid sterility*—F_1 hybrids produced are sterile individuals and unable to produce normal functional gametes.

All these isolating mechanisms either alone or in combination operate to prevent interbreeding between Mendelian populations which are sympatric. All mechanisms have a genetic basis. Sexual or ethological isolation which may be defined as the lack of mutual attraction between males and females of different species constitutes the largest and most important class of reproductive isolating mechanisms in animals. The individuals respond in such a manner to the stimuli they receive from the individuals of the opposite sex belonging to other species, that mating does not occur. Thus, the word ethological refers to behavioural pattern. Ethological isolation becomes a barrier to mating due to incompatibilities in behaviour. Males of one species have specific courtship pattern to which only females of the same species are receptive. The specific reactions of males and females towards each other is known as *species recognition*. In most cases, it is the males that actively search for a mate. *Drosophila*, a dipteran insect commonly known as fruit fly, has been found to be a very useful material for behavioural studies. In 1915, A. H. Sturtevant of Columbia University, USA, was the first to study courtship pattern of *D. melanogaster*. Since then, mating behaviour of numerous *Drosophila* species has been extensively studied by several investigators. Mating behaviour of *Drosophila* consists of species-specific actions which are accompanied by orientation movements. Such actions referred to as courtship displays are made up of several signals which are performed sequentially. Mating occurs only in the female responds by performing acceptance signals. The courtship is initiated by the male which performs a fixed action pattern directed towards the female. The response of potential mate produces informations through which individuals discriminate between conspecific and nonconspecific and the physiological readiness of females to engage in copulation is also known. If the individual is a nonconspecific female, courtship is quickly terminated. Mating takes place only if the potential male is a conspecific receptive female. The forelegs, wings and mouth parts of males are used as signalling organs in most of the species. Male display presents a great diversity among different species. However, the female signals are less in number and diversity than males and are performed by wings, legs, genitalia and abdomen. Females produce signals in response to male courtship displays and these signals are of two types: acceptance response and rejection response. It has been observed that females may walk and even feed also during copulation. But males are inert during copulation. The duration of copulation varies considerably among different species. It ranges from 5 sec in *D. enigma* to 62 min in *D. acanthoptera*.

The phenomenon of sexual or ethological isolation is widespread in *Drosophila* due to which gene exchange between different species is prevented. A large number of investigations have been carried out in different species of *Drosophila* by several workers who have demonstrated that complete sexual isolation exists between some species but is incomplete between others. It is known that it is the females which exercise discrimination during courtship. Mating isolation is based on production and reception of various stimuli by the sex partners. These behavioural devices have classified on the basis of the main sense organs involved.

Different types of stimuli involved in mating behaviour

Ethological isolation is based on the production and reception of stimuli by male and female. On the basis of the main sense organs involved, these stimuli have been classified into different types: visual, auditory and chemical. A male *Drosophila* provides the female a set of stimuli during courtship. Based on these stimuli, the female is able to discriminate between its own and alien males and is stimulated for copulation.

(1) *Visual stimuli*: The role of visual stimuli in mating has been detected in different species of *Drosophila*. All species court during the period of day light and some also court in darkness. However, no species restricts its courtship only during darkness. It has been shown that the presence or absence of light has a profound effect on mating of *Drosophila*. Various species exhibit varying degrees of light dependency in their mating behaviour. They have been classified into three categories by J. Grossfield of City College of New York, USA in 1971:

(a) *Light independent* :-the species mate effectively in darkness also; 2-light dependent—the species are unable to mate in darkness and 3-facultative species—which are depressed by darkness but can achieve some copulations. In light-dependent species (*D. subobscura*) important components of courtship of males appear to be visual. The role of visual cues in *Drosophila* mating has also been detected while studying the mating behaviour of certain eye pigment deficient mutants. For example, white-eye mutants of different species are at a disadvantage in mating in light conditions. Thus, vision plays an important role in *Drosophila* courtship. The inhibition of mating of white-eye mutants in light in different species of *Drosophila* has been explained by suggesting different hypotheses. According to H. T. Spieth of University of California, Davis, USA, eye-pigment deficient mutants of *D. melanogaster* exhibit a deficit of optomotor response. A. W. Ewing and A. Manning of University of Edinburgh, UK, suggested that the mutation in eye pigmentation have some pleiotropic effects which affect the central nervous system of the animals which, in turn, affects the male sexual behaviour. On the other hand, J. Grossfield and his associates of the City College of New York, are of the view that mating deficit of white-eye males of *D. pseudoobscura* in light is due to a neurobehavioural disruption produced by faulty visual input. Further more, orientation of flies can not occur in darkness in light-independent and facultative species but mating may occur due to accidental encounters or as a result of searching movements by the males. The light-dependent species remain immobile in darkness. Hawaiian *Drosophila* species remain immobile during darkness in field and *D. subobscura* females perform dance which must be observed visually by males. In certain species of *Drosophila* (e.g. picture-winged Hawaiian *Drosophila, D. suzukii, D. biarmipes*), males possess dark black patch on their wings which serve as a visual stimulus to the female during courtship. Removal of the black shade in wings by amputation reduces mating success of males. In *D. biarmipes*, both types of males, with or without patch, have been found. Males with black patch on their wings have greater mating success than those without patch. Thus visual stimuli play an important role in mating in certain species of *Drosophila*.

(b) *Auditory stimuli* : Songs, calls and other acoustic signals have precision and specificity; they become more suitable isolating mechanisms than visual stimuli. *Drosophila* females may not become receptive for mating until stimulated by appropriate wing vibration of conspecific males. Males of most *Drosophila* species make wing vibrations which cause the production of sound termed as male courtship songs. These songs have been studied by different workers in different species. The sex songs of males consist of two components: the sine song and the pulse song. The pulse song consists of repeated sound pulses separated by time or interpulse intervals. With respect to pulse songs, there is variation among the different species and also within the species in the number of cycles, pulse-repetition rate and the duration of interpulse intervals. The antennae are the main organs to receive auditory signals in both sexes. Flies of both sexes which are devoid of wings and antennae are mute and deaf. The male sex songs are species-specific. The interpulse interval of male pulse songs is most important and is discriminated by females. Thus, it forms the basis for ethological isolation among different species. When incipient isolation occurs among different strains of the same species, variation in male pulse songs has been noted in some cases. Thus, male sex organs appear to function in mate discrimination by the female and in her final acceptance of copulation.

(c) *Chemical stimuli :* Chemical stimuli which act at a distance (olfactory) or on contact often serve as isolating mechanisms. It has been shown that olfactory stimuli in the form of pheromones are involves in mating behaviour of *Drosophila.* In both sexes, the receptors for olfactory stimuli are present on the third antennal segment. During courtship, the physical contacts between the male and female also results in the transmission of chemostimuli. The male usually taps the female by its forelegs. Chemoreceptors are present on the fore tarsi of males and females have chemoreceptors on their body surface. Chemostimuli are exchanged during tapping of the female by the male. The role of chemostimuli in mating has also been shown in Hawaiian *Drosophila* species in which males of most species engage in lek behaviour (courtship occurs in a limited area away from feeding site). It has been reported that volatile pheromones are produced by both sexes which are essential for the initiation of courtship. The role of chemostimuli in mating isolation has also been demonstrated by amputation of antennae which reduces the ability of *D. pseudoobscura* and *D. persimilis* females to discriminate between their own and alien males.

Thus, there is an ample evidence to show that during courtship exchange of various stimuli between the male and female takes place and mating occurs only when both sex partners reach a state of physiological readiness. Furthermore, various stimuli play important role in mating isolation.

Mode of mating preference and direction of evolution

Sexual isolation has been observed in many species of *Drosophila.* However, the mode and the degree of isolation varies in different cases. In many cases, complete sexual isolation has been observed. Numerous cases of incomplete isolation have been reported among closely related species. Moreover, the mode of mating preference may also vary. The species which are incompletely isolated may show symmetrical (in both directions or both-sided) or asymmetrical (in one direction or one-sided) sexual isolation. Some times geographic populations or strains of the same species may show incipient isolation as a result of genetic divergence caused due to natural selection and genetic drift. The degree and pattern of mating preference have often been used to know the phylogenetic relationships among closely related species. Recently, two opposing models have been proposed to a elucidate the evolutionary sequence of species on the basis of the mode of mating preference between closely related species.

Sexual isolation is caused due to preferential (non-random or assortative) mating between males and females of the same species. This is known as homogamic mating. In the case of incomplete isolation, mating may take place between males and females of different species which is referred to as heterogamic mating. Sexual isolation (or the pattern of mating) may be symmetrical or asymmetrical. The occurrence of asymmetrical isolation has been reported in many *Drosophila* species groups.

Table 1 shows that homogamic matings are more frequent than heterogamic ones and isolation indices remain high (close to 1) in both directions. Thus, there is evidence for preference for homogamic matings in both directions. This is known as *symmetrical isolation.* Females and males of the same species prefer each other. Females of one species discriminate against the males of alien species.

TABLE 1 : Symmetrical sexual isolation between A and B species (male-choice experiments —one type of males with two types of females-males have choice)

Females	Male	% homogamic matings	%heterogamic matings	Isolation index
A+B	A	90	10	0.80
A+B	B	90	10	0.80

Table 2 shows *asymmetrical mating* preference. With A males, there is strong isolation—B females do not accept A males. On the other hand, both A and B females are equally receptive to B males. So there is random mating with B males.

TABLE 2 : Asymmetrical sexual isolation between A and B species (male-choice experiments)

Females	Male	% homogamic matings	%heterogamic matings	Isolation index
A+B	A	90	10	0.80
A+B	B	50	50	0.00

It is clear from Table 3 that there is asymmetrical mating preference but it is just reverse of what has been shown in Table 2. There is strong isolation with B males, but no isolation with A males. A males are readily accepted by both females, but B males are discriminated against by A females.

TABLE 3 : Asymmetrical sexual isolation

Females	Male	% homogamic matings	%heterogamic matings	Isolation index
A+B	A	50	50	0.00
A+B	B	90	10	0.80

The asymmetrical mode of mating preference among closely related species as shown in Tables 2 and 3 has been observed. It has been used to predict the direction of evolution among closely related species and two opposing models have been proposed.*

(i) In 1976 K. Y. Kaneshiro of Hawaii University, USA, proposed that ancestral females discriminate against derived males but females of derived-species mate randomly with males of ancestral species. This hypothesis is based on founder principle (evolution via genetic drift) and the mating preference observed among four species of Hawaiian *Drosophila*.

(ii) In 1979 T. K. Watanabe and M. Kawanishi of National Institute of Genetics, Japan, proposed that it is the females of derived species which do not mate with the males of ancestral species. They proposed their hypothesis on the basis of mating preference observed in *D. melanogaster* and *D. virilis* species groups.

Evidence in support of both these hypotheses have been obtained. Thus, the relationship proposed by these scientists can not be generalised for the whole genus *Drosophila*. However, a consistent relationship having predictive value might exist in certain species groups. The relationships might depend upon ecological and evolutionary histroy of a particular group. The events of speciation may occur in different ways in different cases.

In order to explain how the reproductive isolating mechanisms originate between populations, different hypotheses have been proposed. According to H. J. Muller of Animal Institute of Genetics, Edinburgh, UK, reproductive barriers appear as a side-effect of genetic divergence because populations adapted to different environments acquire genetic differences which lead to reproductive isolation. Th. Dobzhansky of Columbia University, gave more importance to natural selection acting on appropriate genetic variation when the allopatric populations that have an incipient isolation become sympatric. H. L. Carson of University of Hawaii, USA, emphasized the role of genetic drift through founder effect in the origin of reproductive isolation which serves as a barrier to gene flow. Evidences in favour of these theories have been obtained. The development of pre-zygotic isolation as a byproduct of selection or drift is consistent with a widely accepted model of allopatric speciation. In this model, populations become genetically different due to adaptations to different ecological conditions and gradual genetic divergence is accompanied by reproductive incompatibility. Isolation has been induced by selection and also by inbreeding in many cases. A large number of investigations on sexual isolation between and within the species of *Drosophila* have indicated the evolutionary origin of sexual isolation. Recently, the phenomenon of sexual isolation has also been studied in *Drosophila* species occurring in India by the present author and his co-workers[3]. Interesting results with respect to the evolutionary significance of this phenomenon have been obtained.

The phenomenon of sexual or ethological isolation is widespread in *Drosophila*. Many cases of incomplete isolation have been reported in various species groups. The pattern and degree of sexual isolation observed among closely related species have often been used to know their phylogenetic relationships. Various stimuli such as visual, auditory and chemical which are exchanged during courtship between male and female are often used for mate recognition.

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Further readings

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Letters to the editor

Effects of salinity in the tunicate, *Ascidiella aspersa*

Ascidiella aspersa Müller, a simple tunicate available in good numbers in Madras coast (East coast of India), shows seasonal fluctuations with abundance during the period from April to September-October. Normally with the onset of rains in September-October, they become rare and fresh settlement starts in the month of April. To account for the disappearance of the species during the particular period of the year, certain preliminary studies, first of their kinds, on its osmoregulation were carried out. Muthu[1] has reported that the salinity of harbour waters may go below 20% during rainy season. That the animal has a lower salinity tolerance limit of 20% and an upper tolerance limit of 40% was also reported earlier[2]. In the present study, water content variation of the animal in several salinities was investigated and in doing so the relationship between the Test (Tunic) and the tissues of the animal was also studied. Such a study was necessitated to settle whether the shrinking of the Test takes place in lower salinities. Observations on the behaviour and ability of the animal for attachment to the substratum in various salinities were also made.

Specimens of *Ascidiella aspersa* Müller were collected from the boat basin area of Madras harbour. They are normally found attached to buoys, floats and anchored ships. Animals in the laboratory were maintained in glass troughs under 4.5" of sea water of normal salinity (34%). The sea water was changed daily.

In the analysis of water content, animals ranging in dry weight from 25.9 mgm to 72.8 mgm were used. These animals were freed from any adhering particles and separated into Test and tissues. They were carefully blotted and weighed using a single pan electric balance (all the soft parts of the animal except Test are called Tissues in the text.). This separation into Test and tissues was found necessary for the clean blotting of the water from body parts of the animal. In an oven maintained at 80°C the animals were dried to constant weight. In order to study the water content variation, if any, in various salinities the animals were directly transferred to the respective salinities of 20%, 25% and 40% from normal sea water. The subnormal salinities were provided by diluting normal sea water with distilled water. On the other hand, supranormal salinity of 40% was prepared by the addition of sodium chloride. Animals transferred to new salinities were kept for a period of 24 hrs before taking the respective wet and dry weights. The data obtained were processed for mean and standard deviation. Analysis of variance was applied for testing the difference between means.

In the study of Test-tissue relationship, animals ranging in dry weight from 7.1 mgm to 101.3 mgm were used. The test and tissues were separated and wet/dry weights were taken separately. From the total weight of the animal, the percentage of Test was calculated. The coefficient of correlation r was determined and the observed r was tested for significance using t-test.

The adhesive secretion of the animals was collected by allowing the animal to remain in contact with microglass slides within the trough where they were being reared. Such slides were treated with 0.1% Toluidine blue.

Table 1 and Fig. 1 show the percentage of water content in the tissues in relation to normal and various other salinities. The calculated mean and standard deviation are represented in figures. It can be seen that the percentage of water content increased in animals acclimated to lower salinities and that water content decreased in the higher salinity. From the analysis of variance, the calculated F value obtained was 3.66 which is more than table value at 5% level of significance. Thus the difference in the mean values of the samples is significant.

TABLE 1 : Shows water content (%) in the tissues of *A. aspersa* in various salinities

	Percentage of water content in various salinities			
	40%	34%	25%	20%
	84.20	86.85	84.55	86.69
	81.80	85.74	84.79	89.74
	84.04	84.39	90.43	84.84
	86.58	87.21	91.36	84.78
	77.74	85.58	89.50	87.42
Mean	82.87	85.95	88.13	86.69
S.D.	± 3.33	± 1.12	± 3.22	± 2.06

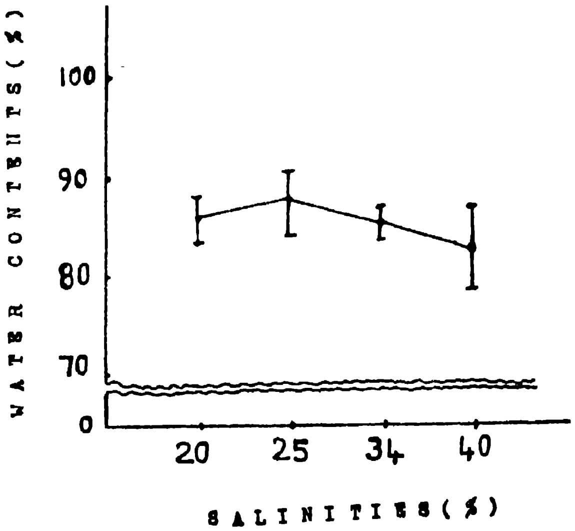

Fig. 1. Shows percentage of water content (Mean ± Standard deviation) in the tissues of *A. aspersa* in various salinities.

The water content analysis of the Test of animals acclimated to various salinities showed no significant changes (data not given) indicating that Test may not be reactive to changes in salinity.

Figure 2 displays the relationship between the Test and total weight of animals studied. It can be seen that slight individual variations occur in the percentage of Test of the animals. On an average, it occupies 39.21% of the total weight of the animal. The coefficient of correlation obtained was 0.12 indicating a very poor correlation. The coefficient r was insignificant at 5% level.

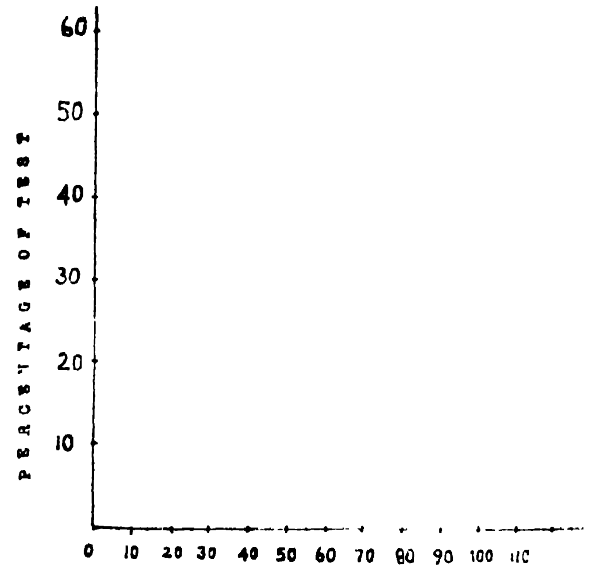

Fig. 2. Shows percentage of Test (tunic) of *A. aspersa* plotted against total dry weight

The adhesive secretion of the animals on reaction with Toluidine blue displayed metachromasia indicating the presence of acid mucopolysaccharide. In the case of animals maintained at subnormal salinities, it was not possible to collect their secretions.

When the animal was introduced into new salinities, the main behavioural responses observed are : (1) shrinking of the Test or the animal as such, (2) partial closing of the rim of the siphons and (3) poor responses to mechanical stimulus like needle pricks.

The finding that *Ascidiella aspersa* showed an increase in water content at lower salinities and a decrease in water content at higher salinity implies that it is an osmoconformer. Two other genera of ascidians—*Molgula* and *Ascidia* —have already been reported to be osmoconformers[3]. The present species has a lower tolerance limit of 20%. In the light of these facts, it is likely that the lowering of salinity might be a major causative factor leading to the mass mortality of ascidians in Madras harbour. Dybern[4], based on his studies on *Ciona intestinalis,* stated that extreme salinities can cause failure of temporary spawning or total failure of development of the embryos.

It was mentioned earlier that animals maintained in the sea water showed a tendency to adhere to either the sides or bottom of the glass troughs by making a characteristic secretion from its Tunic. This secretion consists mainly of acid mucopolysaccharide which is known for its adhesive function. The fact that animal showed no tendency to get attached to the glass substratum when they are in subnormal salinities might indicate the weakening of the animal in lower salinities.

In the light of the observation that water content in the Test of the animal is unaffected with alterations in salinity, it has to be inferred that the Test has no specific role connected to the osmotic balance of the animal. Thus the shrinkage of the Test in lower salinity can be attributed to a mechanical process rather than to any physiological activity. It is known that organisms may respond to changes in salinity by contraction of the body, by closure of shells and withdrawal of sensitive parts[5]. But it can be interpreted that the contraction and partial closing of the siphons might be to avoid the low salinity medium. This was further confirmed from a study of the rate of water transport by the animals at lower salinities in which only less amount of water was transported[2].

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Physicomathematical aspects of the stability of a cell

The question of stability of a cell is an important problem as it seems to be central to determining whether a tumour is non-malignant or like cancer cells which create malignant tumours[1]. An eukaryotic cell is governed by the following characteristics :

The outer surface of the cell is represented by an unknown functional equation

$$\Gamma(x, y, z; t) = 0, \tag{1}$$

where Γ denotes the outer srface of the cell. For a spherical animal cell, the equation of Γ at any time t can be expressed as

$$r = R(t), \tag{2}$$

where $R(t)$ denotes the radius of the cell at time t. Obviously, $R(O) = a$ is the radius of the daughter cell. The vibrational frequency $\omega(t)$ of a pulsating cell is directly related to $R(t)$ which further depends on viscosity, surface tension and density of the cellular fluid[2,3] (A pulsating cell is accompanied by sol-gel changes[4]).

The growth of a cell starts when the available protein content expressed by $\sigma(x, y, z; t)$ exceeds a critical value[5] σ_1. (The cell volume is proportional to the cellular protein content[6]). The cell dies when it falls below a certain level.

The growth of nucleus and cytoplasm produces internal pressure differentials which cause the motion of cellular material[7]. This is assumed to be governed by

$$q = -\nabla p, \tag{3}$$

where $q(x, y, z; t)$ is the particle velocity and $p(x, y, z; t)$ is proportional to internal pressure. The change in volume of the nucleus produces dominant tangential stress changes in the cytoplasm and nuclear membrane[8]. If ϕ be the velocity potential, one has for the pressure, $p = \rho \frac{\partial \phi}{\partial t}$, where ρ is the density.

A surface tension force S is proportional to the mean curvature K of the cell. The pressure inside the cell is a function of surface tension, S which is again proportional to the mean curvature K i.e.

$$p = \alpha K \tag{4}$$

where α is a constant.

Surface tension is an important factor to maintain the compactness of the cell.

If the pressure $p(r, t)$, protein content $s(r, t)$ and the radius $R(t)$ of a cell are perturbed by any small amount ϵ, the cell becomes unstable and radically departs from its original spherical shape[9,1,10]. The stability of a cell may be considered as a limiting case of nucleo-cytoplasmic ratio of a cell[11]. The relative density of cytoplasm in different regions of the cell may determine the nuclear position[12]. A growing cell first reaches a certain maximum size, attains a critical mass and then divides into two small daughter cells before growth can continue. By division a cell can obtain more surface area per mass of cell substance. Thus there is a limiting ratio of cell surface or volume to cell mass[13], which is different for different kinds of cells. The stimulus for cell division is brought about, in part at least, an osmotically induced increase in cell volume which results in an increase in Na^+ concentration of the cell. This takes place when the threshold value of the surface/volume ratio is reached[12]. Increasing volume implies increasing area, but the relationship between these two parameters is not proportional[14].

The growth depends on the ratio of volume or mass of nucleus to volume or mass of cytoplasm (growth of cell size is primarily cytoplasmic[15]). The ratio may be nearly constant for any given cell-type of a given species[12,16]

The mass and volume of the nucleus and cytoplasm are related in such a way that if one of them changes the other must also change to maintain the stability of a cell. Let the nucleus be initially stable within the cytoplasm. Stability can be maintained due to attainment of a critical cell size if the initial and critical ratio of cytoplasm to nuclear mass is equal[14] i.e.

$$\frac{m_1}{m'_1} = \frac{m_2}{m'_2} \qquad \frac{\vartheta_1\rho_1}{\vartheta_2\rho_2} = \frac{\vartheta'_1\rho'_1}{\vartheta'_2\rho'_2} \tag{5}$$

where m_1, ϑ_1, ρ_1 and m_2, ϑ_2, ρ_2 are the mass, volume and density of the daughter nucleus and cell respectively; the dashes represent the corresponding values at the critical stage before division can start. Since a cell can only double its mass, an adult cell will be stable with the nucleus only if

$$\frac{\vartheta'_1}{\vartheta_1} = \frac{2\rho_1}{\rho'_1} \qquad (6)$$

But it is found that although $\vartheta'_1 > \vartheta_1$ but the change of ρ'_1 from ρ_1 is not so appreciable ($\rho'_1 > \rho_1$). The above relation can be restored only by division of the nucleus followed by a division of the original cell into two daughter cells[12].

A cell may be stable with the nucleus if the volume ratio at the two stages are equal i.e.

$$\frac{\vartheta_1}{\vartheta_2} = \frac{\vartheta'_1}{\vartheta'_2} \qquad (7)$$

Since the nuclear volume ϑ'_1 remains relatively constant[15] in comparison with the cytoplasmic volume ϑ'_2 at any time t, a cell will thus be unstable during the cycle. The relation discussed above simply shows the controlling capacity of the cytoplasmic volume by the nuclear volume. It is to be noted that in giant amoeba *Chaos chaos*, a small nuclear/cytoplasmic volume ratio is not a sufficient condition for the induction of division[18]. If cytoplasm from *Amoeba* is periodically removed[18, 19], growth continues indefinitely and the cell will not divide unless it is allowed to reach a certain minimal mass. Again, since the doubling of DNA takes place only between divisions[20], thus if the nuclear mass is assumed to be doubled, one gets from relation (5)

$$\frac{\vartheta'_2}{\vartheta_2} = \frac{2\rho_2}{\rho'_2} \qquad (8)$$

When cell division is imminent, the above ratio is upset since at the time of division ϑ'_2 is almost doubled of[21, 22] ϑ_2 but the change of ρ'_2 from ρ_2 is very small (ρ'_2 is generally[12] $<\rho_2$). The event in cell division thus seems to be the doubling of the DNA content of the nucleus[13] together with the histone content[23]. (Not only the nuclear accumulation of histones but also the actual synthesis of histones in proliferating cells occurs tightly coupled to DNA replication[23]. Ca^{++} and Mg^{++} are necessary to bind DNA and histones[24]).

If the masses of both nucleus and cytoplasm are assumed to increase exponentially (up to a certain limit depending on environmental conditions), one gets from the mass ratio relationship at any time t

$$e^{\alpha_1 t} = e^{\alpha_2 t} \qquad (9)$$

where α_1 and α_2 are called the growth characteristics of the nucleus and cytoplasm respectively.

The above relation can be satisfied only when $\alpha_1 = \alpha_2$ (i.e. growth pattern is identical). But experimentally it is found that[15] $\alpha_1 \neq \alpha_2$, thus an instability of the situation will continue throughout the cycle (until the cell divides). The same argument holds also for a linear growth[24].

The ratio of surface area and volume of a growing cell with the nucleus further illustrates the unstability of the situation[9]. The surface area of a cell is directly concerned in the rate of cell metabolism[12]. A slight change of the ratio ρ_1/ρ_2 will indicate the instability of a cell. The nucleoplasm may be thicker or thinner and cytoplasm thinner or thicker depending on cell type[24]. (While one gains in mass density, the other losses[11]). The stability of a cell can be maintained if

$$\frac{S_2}{m_2} = \frac{S'_2}{m'_2} \qquad (10)$$

where m_2 and S_2 are respectively the mass value and surface area at the beginning of the cycle and dashes represent the corresponding values at the adult stage. But as m_2 increases, area covered by a cell membrane S_2 does not increase proportionally. More surface area can be provided for a growing mass of protoplasm only by division[25]. The change of S_2/m_2 with growth leads to the disadvantage of the cell surface (proportional growth) until an equilibrium between input of metabolites and dissimilation is obtained. In this case, the critical size of the cell is reached[26]. The change in surface area, δS at the adult stage of the cell is much less than the change in volume, δV of the cytoplasmic fluid. When the threshold value of this ratio, $\delta S/\delta V$ is reached, the loss of integrated functions within the cell increases and thus disorganization will lead inevitably to cell death, if division of the cytoplasmic volume does not occur[12].

Nuclear-cytoplasmic relations are affected by temperature[24], gravity[27], magnetic field[28-31] and other environmental conditions.

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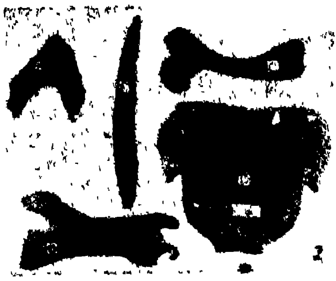
Remains of swamp deer, and some other wild fauna of historic Sundarbans from Boral, 20 km south of Calcutta

During mid-1986, some skeleton remains of swamp deer, chital, wild buffalo, wild boar, estuarine crocodile, marsh crocodile, species of marine and fresh water turtles and fish remains were unearthed from a village "Boral" (*c* 22° 29' 54" N, 88° 35' 20" E), 20 km south of Calcutta. The remains are interesting from the point of early zoogeographical distribution, as some of these species are now extinct in Bengal. They were excavated along with numerous potsherds, wooden log, net floater, metal bowl and terracotta figurines, while renovating one ancient tank "Sendighi" covering an area of 15 acres. This place, in the past, belonged to the Sundarbans swamp forest, through which the ancient Bhagirathi once flowed from north to south, where on its western bank, the present village which was an ancient quay, now stands. During the excavation, Dr. Shibaprasad Banerjee, a noted agricultural expert of the village led us to the site and narrated the background of the area. The animal remains and archaeological implements were procured by the Zoological Survey of India and the Directorate of Archaeology, Calcutta, West Bengal respectively, for study. Altogether seven strata were unveiled in the site with a chronological range of 1200 AD to 200 BC. The majority of the remains were obtained from the 6th layer from surface (4/5 meters). This layer, locally known as "Pandav Pora", consisted of rotten wood and boles of mangrove species, mostly

Plate I



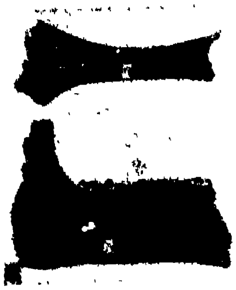


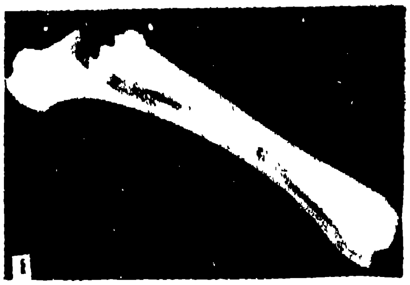
Fig. 1 : (A) The broken lower jaw of *Crocodylus palustris* (Lesson); (B) Tooth of *Crocodylus palustris* (Lesson); (C) Tooth of *Crocodylus porosus* Schneider.

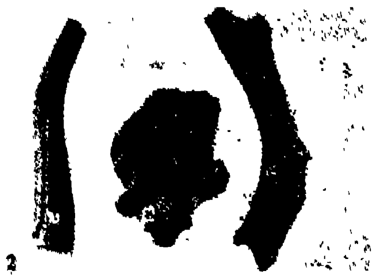
Fig. 2 : (A) Lower jaw of *Lepidochelys olivacea* (Eschscholbz); (B) Axis vertebra of *Chitra indica* (Gray); (C) Left humerus of *Trionyx gangeticus* Cuvier; (D) Plastron of *Hardella thurjii* Gray; (E) Pectoral spine of *Mystus* sp.

Fig. 3 : (A) Piece of carapace of *Trionyx gangeticus* Cuvier; (B) Piece of carapace of *Chitra indica* (Gray); (C) Piece of plastron of some unknown turtle.

Fig. 4 : (A) Broken left mandible of *Sus scrofa cristatus* Wanger; (B) Left humerus without head and condyle of some undetermined ungulate;

Plate II





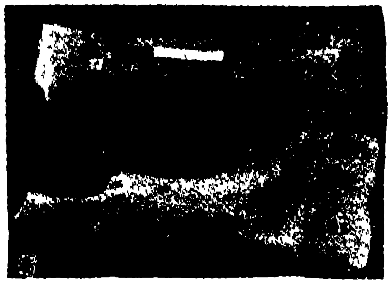


Fig. 1. Complete right radio-ulna of *Cervus duvauceli* Cuvier.

Fig. 2 : (A) Broken tine of antler of *Axis axis* Erexleben; (B) Broken antler with pedicel of *Cervus duvauceli* Cuvier; (C) Broken tine of antler of *Cervus duvauceli* Cuvier.

Fig. 3. Broken rib of *Bubalus bubalis* Linnaeus.

Fig. 4 : (A) Left metatarsal bone of *Bubalus bubalis* Linnaeus; (B) Left humerus without head of *Bubalus bubalis* Linnaeus.

Sundri and Garan, impregnated in sandy silt of dark grey colour.

The species recognised in the faunal remains are :

1. Swamp deer, *Cervus duvauceli* Cuvier, represented by teeth, antlers and limb bones (Plate II, Figs. 1, 2B, 2C).

2. Chital, *Axis axis* Erxleben, represented by lower jaw and antlers (Plate II, Fig. 2A).

3. Wild buffalo, *Bubalus bubalis* Linnaeus, represented by teeth, jaws, ribs, vertebrae and limb bones (Plate II, Figs. 3, 4A, 4B).

4. Wild boar, *Sus scrofa cristatus* Wagner, represented by teeth and jaw bones (Plate I, Fig. 4A).

5. Estuarine crocodile, *Crocodylus porosus* Schneider, represented by teeth, maxilla and mandible (Plate I, Fig. 1C).

6. Marsh crocodile, *Crocodylus palustris*, (Lesson), represented by teeth and mandible (Plate I, Figs. 1A, 1B).

7. Narrow headed soft shelled turtle, *Chitra indica* (Gray), represented by vertebra, humerus, carapace and plastron (Plate I, Figs. 2B, 3B).

8. Fresh water turtle, *Trionyx gangeticus* Cuvier, represented by carapace and plastron (Plate I, Figs. 2C, 3A).

9. Fresh water turtle, *Hardella thurjii* Gray, represented by a complete plastron (Plate I, Fig. 2D).

10. Marine turtle, *Lepidochelys olivacea* (Eschscholbz), represented by jaw and carapace (Plate I, Fig. 2A).

11. Bagrid fish, *Mystus* sp., represented by a pectoral spine (Plate I, Fig. 2E).

Out of the recognised species here, barring the swamp deer and wild buffalo, all the other species are still extant in the present day, heavily shrunk Sundarban's restricted area, with a thin and rapidly dwindling population. At least three mammalian species *viz.* the smaller one-horned rhino, the swamp deer and the wild buffalo were inhabitants of the historic Sundarbans, which had an area of 11,000 sq. km, in undivided Bengal, in the last century[1-3]. **But since** when they became totally exterminated is not precisely known to Zoologists. Specimens of the rhinoceros and wild buffalo obtained earlier testify to their one time existence in the forests. One adult male and one juvenile rhino collected from the Sundarbans in the 19th century are still in the possession of Indian Museum, Calcutta. Besides stories of hunting wild buffalo in the late 19th century, skeleton remains of wild buffalo unearthed from different belts of Sundarbans, depict early existence of the animal in the forests. But the presence of swamp deer, though its distribution in the Sundarbans has been quoted in early zoological literature, has never been substantiated by recorded evidence. So, the present find is not only remarkable as a first record, but it also testifies that the swamp deer existed in the forest even twelve centuries ago.

Though, the few animal remains (as for example, specimen figured in Pl. I, 4B), specially the plastron and carapace of undetermined turtles which could not be identified, still the identified remains which mostly belong to animals of Sundarbans biomass draws to the conclusion : (1) the Sundarbans was spread much beyond its present limit in the north from the sea-coast, (2) there was a sizable population here of estuarine crocodile which is the largest reptile living, (3) quite a number of marine turtles, now rare, used to frequent the area, might be for reason of breeding, (4) it substantiates that swamp deer was a resident animal of the area for a few century.

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Action of light and darkness on herbicide toxicity to seed germination

Herbicides have been known to inhibit the germination of weed seeds in agricultural crops[1]. However, the response of germinating seeds to herbicides are distinct from those of established plants[2-4]. Various types of herbicides allow the establishment of seedlings before exerting a lethal effect and death of seedlings may be preceded by malformation of shoots or roots[5]. Little attention has been paid to such basic aspects as the influence of various environmental factors on herbicide behaviour with respect to seed germination[6-7]. The present communication deals with the effects of 2,4-D (2,4-dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) on the germination of seeds of *Abutilon indicum* (L.) Sw., a very common and troublesome weed in high uncultivated lands of West Bengal. The aim is to determine the effects of these two herbicides at different concentrations and under darkness as well as different portions of the visible light spectrum.

Fruits of *A. indicum* were collected from the experimental garden of the Botany Department, University College of Science, Ballygunge, in October 1974. The dispersal units of each individual fruit were at first separated and the pericarp of each unit removed to set the seeds free. The seeds, thus obtained, were stored in brown paper containers at room conditions (24-32°C). Since the seeds were found to possess very-low germinability due to the impermeability of the testa, they were scarified with conc. H_2SO_4 for 2 hr and followed by thorough washing in water. Germination tests were conducted by scattering acid-scarified seeds in Petri-dishes (9 cm diam) upon 1 circle of Whatman No. 1 filter paper, moistened with 4 ml of water or test solutions. Aqueous solutions of the herbicides were prepared and diluted to give 1, 10, 100 and 1,000 ppm of active ingredient. There were 25 seeds per dish and 4 dishes per treatment. The pH of the solutions was adjusted to 7.0. The dishes were placed in a germinator maintained at 25±1°C. While some of the dishes were covered with a piece of black nylon cloth, most of them were exposed to light from a fluorescent lamp. In the latter case, the dishes were wrapped with a double layer of coloured cellophane in order to obtain the different light qualities, such as white, blue, green, yellow and red.

The combined herbicide-light effect was measured by germination counts from those of the control. Any value above the control is indicative of stimulation and below the control that of inhibition. In the present study, both 2,4-D and 2,4,5-T stimulated seed germination of *A. indicum* at lower concentrations (1 and 10 ppm) as well as partly or completely inhibited the process at higher concentrations (100 and 1000 ppm).

TABLE 1 : Herbicidal action on the seed germination of *A. indicum* as modified by light and darkness

Conc. of herbicide (ppm)	Darkness	Percentage germination				
		Light				
		White	Blue	Green	Yellow	Red
2, 4-D						
1000	0	0	1.0 ± 1.2	0	0	0
100	0	17.0 ± 5.8	37.0 ± 4.5	5.0 ± 2.5	9.0±4.1	1.0±0.3
10	79.0 ± 4.5	81.0 ± 4.8	66.0 ± 8.3	45.0 ± 6.5	30.0±5.9	56.0±3.3
1	90.0 ± 4.1	65.0 ± 8.2	65.0±8.2	59.0 ± 9.8	28.0±8.9	94.0±0.3
2, 4, 5-T						
1000	3.0 ± 2.5	1.0 ± 1.2	0	0	14.0±6.8	5.0±2.5
100	30.0 ± 0.5	2.0 ± 1.6	41.0±12.3	18.0±5.4	31.0±12.8	11.0±13.5
10	93.0 ± 5.8	40.0 ±16.3	64.0±8.3	71.0±8.2	49.0±2.9	83.0±10.3
1	72.0 ± 11.5	72.0 ±11.5	95.0±4.0	71.0±8.2	51.0±7.3	65.0±7.3
Control	84.0±9.8	33.0 14.8	27.0±9.0	40.0±13.3	33.0±7.8	21.0±9.0

It has been generally found that herbicides affect the growth of plants more in light than in darkness[8]. This does not follow in the case of germination of *A. indicum* where herbicides tend to be more potent in the dark than in the light. Moreover, 2, 4, 5-T was observed to be more effective than 2, 4-D. This proves that the toxicity of the herbicides depends on the structural configuration of the chemical.

A difference in herbicidal activity, as modified by spectral sensitivity, was evident in *A. indicum*. It was noted that there was germination inhibition in the 2, 4-D series under the influence of both green and red light. Such activity was also noticed in the 2, 4, 5-T series under the impact of all portions of the visual spectrum except the red. Interestingly enough, a combination of lower concentrations of 2, 4-D with either green or red light resulted in promotion of seed germination. Similarly, an interaction of lower concentrations of 2, 4, 5-T with either white or blue light exerted a promotive effect on germination.

The general pattern of reduction in germination percentage in different parts of the light spectrum was not similar to the pattern of reduction in dry-weight yield for photosynthesis[6]. This suggests that the effect of herbicides on germination may be operative through a process not related to photosynthesis but through some other mechanisms in metabolism.

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Swarming and mating of Chironomids (Diptera : Chironomidae) in laboratory condition

Like other nematoceran diptera a great majority of chironomids also possess the ability to form swarms essential for mating[1]. Swarming in nature was chiefly studied by several workers[2-4] but there are only a very few account of the phenomenon in the laboratory.

The present studies are based on observations on the sequences relating to the swarming and mating patterns in the laboratory.

Stock colonies of each of the five species of chironomids viz. *Kiefferulus barbatitarsis* (Kieffer), *Chironomus filitarsis* Kieffer, *Glyptolendipes barbipes* (Staeger), *Tanytarsus fuscithorax* Skuse and *Tanypus bilobatus* (Kieffer) were maintained for the purpose in separate nylon cages (10 cm x 10 cm x 10 cm) of card board framing. Artificial day light condition was made with a double fluorescent tubes from the ceiling of the culture room. The lamps of 25, 40, 60 and 100 wts were also used for providing lights of various intensities. The lights were switched on at 18 hrs and were off at 6 hrs. Since no automatic light changer was available, dawn and dusk conditions were made by placing shades of the sides and ceiling of the cages.

In the appropriate condition 70 adults of *K. barbatitarsis* (♂ : ♀ = 3:4) and 77 adults of *G. barbipes* (♂ : ♀ = 4 : 3) emerged from the culture and were observed to swarm at 7-8 hrs and 17-30 to 18-30 hrs each day. At the on set on swarming, males initiated the phenomenon by stroking their antennae with the fore tarsi. They then walked rapidly along the sides of the cage and exhibited a positive phototropism. Similarly, the males and females of *C. filitarsis*, *T. fuscithorax* and *T. bilobatus* emerged at the rate of 2:3, 3:4 and 2:4 respectively. The females began walking on the wall of the cage in 1 or 2 minutes in *C. filitarsis*, *K. barbatitarsis* and *G. barbipes*, 4-5 minutes in *T. fuscithorax* and 5-10 minutes in *T. bilobatus* immediately after start of male. The males then performed short flights from one side of the cage to the other and took a turn around the cage and returned to the land. Both males and females of *T. bilobatus* were looked laxy in flight. In contrast, the females of *G. barbipes* were most active among those investigated here. When the light was switched off at 6 hrs, the swarming took place at artificially dimmed condition of light. It was observed that the species of *C. filitarsis* and *K. barbatitarsis* swarmed earlier than *G. barbipes* and *T. fuscithorax*. A few males of *T. bilobatus* were seen to fly from one side to the other of the cage.

Nearly 30-40% males of *C. filitarsis*, 40-60% of *K. barbatitarsis*, 20-30% of *G. barbipes* and 30-50% of *T. fuscithorax* participated in the morning swarm. The number of swarming individuals began to decrease soon only a few minutes after initiation of swarm. The swarming of *G. barbipes* and *T. fuscithorax* took place earlier than in *C. filitarsis* and *K. barbatitarsus* alighting even the last male individual.

Regarding the height and shape of the swarm it became evident that the swarm was greatly dependent to the number of individuals. During this investigation it became apparent that swarming with 10 individuals or less concentrated about half way between the floor and the ceiling of the cage, but with 16 or more, the phenomenon remained confined near the floor and at times ceiling was also found to be used. Vigorous swarmers remained usually at the upper half of the swarm.

The pattern of flight of swarming individuals was studied in *K. barbatitarsis* and *T. fuscithorax*. The swarming flight consisted of 2 types—zig-zag and circular. In the former type alternate back and forth movement synchronised with frequent up and down movements and the insect flew from one side to another while in circular movement one or more successive vertical loops appeared between the zig-zag movements. During the formation of a loop, the insect turned itself twice so that it generally flew forward for most of the way without ture backward flight. Thus the insect sometimes flew laterally over a part of the loop formed in swarms of all sizes. The flight pattern of female though not identical with that of male, was so organized as to bring it into a close relationship with the male swarm.

Chironomids initiated copulation in a swarm and there appeared to be little doubt that the main function of the swarm was to bring the sexes together. Mating on the ground without swarming occurred in *C. filitarsis*, *T. bilobatus* and sometimes in *T. fuscithora*. Mating activity and behaviour were investigated in the cages and also by putting each of the individuals male and female of *C. filitarsis*, *T. fuscithorax* and *T. bilobatus* in small glass vials, the lids of which were tied with fine nylon net. The flies usually alighted on their sides with the ventral surfaces opposed and faced in the same direction resulting ultimate and to end position. Before mating the male ran after the female and in this action the forelegs of both the individuals were put forward. On meeting the partner the male seemed to feel her with forelegs and the palps. It used the forelegs to press the partner down in order to adopt the mating posture. The midlegs were also often used in this process. On reaching such a position, the tip of its abdomen curved down. In most cases the male approached its partner from behind, the tips of abdomens of both the mates touched and copulation began. Consequently, the male put itself on the back of the female at the beginning of the copula and the tip of their abdomen connected and the two partners faced in same direction. This face to back position sometimes persisted during the whole operation until the partners separated.

The swarming behaviour of *C. filitarsis* and *K. barbatitarsis* corresponded to those of others[5-7]. In the light of present observation it could be referred that there was much less activity in swarming at dusk than at dawn in the laboratory condition. The mating on ground observed in this investigation appeared to conform to that described by others[4, 8].

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Free amino acid composition in the cell pool of three Indian edible mushrooms

The nutritive value of mycelial biomass has long been established to be largely dependent on its protein content more specifically on its amino acids composition. A number of scientists from different parts of the world have estimated the amino acids qualitatively and quantitatively in *Agaricus blazei, A. campestris, Pleurotus* sp., *Lepiota* sp. and *Termitomyces* sp.[1-3] The types and amount of amino acids in the cell pool of several cultivated mushrooms have earlier been reported[4-6].

It has been reported that the composition of free amino acids in mushrooms is not only dependent on species but on the environment also in which they grow as revealed from the studies on *Boletus edules, B. luteus, B. variegatus, Cantharellus cibarius* and *Armillaria mellea*[7]. Several mushrooms belonging to Tricholomataceae and Agaricaceae have been reported[8-9] to contain a considerable amount of free amino acids (700-1600 mg/100 g dry matter). Amino acids namely alanine, glutamate, proline and arginine in *Agaricus bisporus* and alanine, glutamate, valine, glycine and leucine in *Pleurotus ostreatus* have been observed[10-11] to be predominant in proteins and free amino acid pool. Fifteen to sixteen free amino acids in *Stereum* sp., *Lentinus edodes* and *Polyporus versicolor* have been evaluated[12]. A report[13] on free amino acids composition of *Boletus luridus, Hygrophorus hypotejus* and *H. olivaceoalbus* has indicated that alanine, proline and aspartate are abundantly present in most species.

The present experimental programme has been undertaken to estimate the free amino acids in the cell pool of the submerged mycelia of *Lentinus cladopus* Lev., *Lentinus squarrosulus* Mont. and *Collybia maculata* Alb. & Schw. growing in basal (glucose-yeast extract-peptone medium) and the optimum media, maltose-yeast extract medium, sucrose-peptone medium and mannitol-yeast extract medium of the fungi in sequence.

Cultural methods and preparation of inoculum were done following Roy and Samajpati[14]. From the nutritional requirements of the mycelia, maltose, sucrose and mannitol (5% level each) of the carbon sources and yeast extract, peptone and yeast extract (0.5% level each) of the nitrogen sources were observed to be optimum for *L. cladopus, L. squarrosulus* and *C. maculata* respectively for maximum protein production. The extraction of cell pool amino acids and desalting of the extract were followed by the methods of Bhattacharjee and Banerjee[15] and of Plaisted[16] respectively. The methods of chromatographic separation and quantitative estimation of free amino acids were of Fahmy and Berner[17-18] and of Giri *et al.*[19] respectively.

The data in table 1 reveal that the amino acid composition in the cell pool in all the test fungi are good so far as the essential amino acids are concerned. The amino acids in the cell pool, growing in basal and optimal media do not show any remarkable variation, although a little increase in some amino acids is noticed.

L. cladopus is observed to contain higher amount of isoleucine in comparison to others, while *L. squarrosulus* and *C. maculata* are rich in leucine and phenylalanine contents respectively. All test fungi show no cystine but a little amount of proline. Methionine is present in considerable amount in both species of *Lentinus*. A relatively higher value of free amino acids have been reported[8-9] in Tricholomataceae and Agaricaceae

TABLE 1 : Data (Mean)* showing the amount of free amino acids present in the cell pool of *Lentinus cladopus*, *Lentinus squarrosulus* and *Collybia maculata* grown under submerged conditions in basal and optimum media

Amino acids	Amount g/100 g of dry mycelial weight					
	Lentinus cladopus		*Lentinus squarrosulus*		*Collybia maculata*	
	Basal medium	Optimum medium	Basal medium	Optimum medium	Basal medium	Optimum medium
Leucine	—	—	2.91±0.03	2.88±0.02	2.20±0.03	1.92±0.11
Lysine	1.37±0.09	1.47±0.08	2.54±0.06	2.79±0.12	0.86±0.04	2.07±0.09
Isoleucine	4.31±0.03	3.93±0.12	1.58±0.12	1.19±0.09	—	—
Aspartate	2.83±0.12	2.69±0.03	0.97±0.09	1.11±0.06	—	—
Histidine	1.27±0.11	1.56±0.07	1.87±0.04	2.47±0.10	2.73±0.12	2.69±0.06
Glutamate	3.09±0.09	2.83±0.09	—	—	1.79±0.06	2.41±0.03
Methionine	0.89±0.01	1.07±0.11	1.07±0.10	1.22±0.06	—	—
Cystine	nd	nd	—	—	—	—
Proline	0.25±0.05	0.39±0.06	0.37±0.06	0.21±0.05	0.29±0.02	0.43±0.11
Threonine	—	—	0.93±0.02	0.87±0.03	—	—
Serine	—	—	—	—	0.85±0.01	0.76±0.05
Valine	—	—	2.63±0.09	2.94±0.11	—	—
Tryptophan	2.37±0.07	2.77±0.11	0.95±0.11	0.69±0.09	—	—
Tyrosine	—	0.50±0.03	—	—	—	—
Phenylalanine	—	—	—	—	3.31±0.12	2.87±0.07
Alanine	—	—	—	—	1.89±0.06	1.27±0.11
Asparagine	—	—	—	—	2.37±0.05	2.55±0.12
Arginine	—	—	—	—	0.49±0.03	0.63±0.03

* Mean data of three replicates under identical conditions; nd = Not detemined.

but the amino acids in members of these families qualitatively resemble the present findings. According to the literature[10-11] alanine, glutamate, proline and arginine in *Agaricus bisporus* and alanine, glutamate, valine, glycine and leucine in *Pleurotus ostreatus* are reported to be predominant while the present study shows that isoleucine, leucine, aspartate, valine and histidine are predominant cell pool amino acids. The report[13] on *Lentinus edodes* and *Stereum* sp. indicates the presence of 15-16 free amino acids but in the present investigation, 9-10 cell pool amino acids have been detected in each of the test fungus. The findings[7] on several species of *Boletus*, *Cantharellus cibarius*, and *Armillaria mellea* resemble the present findings to a great extent.

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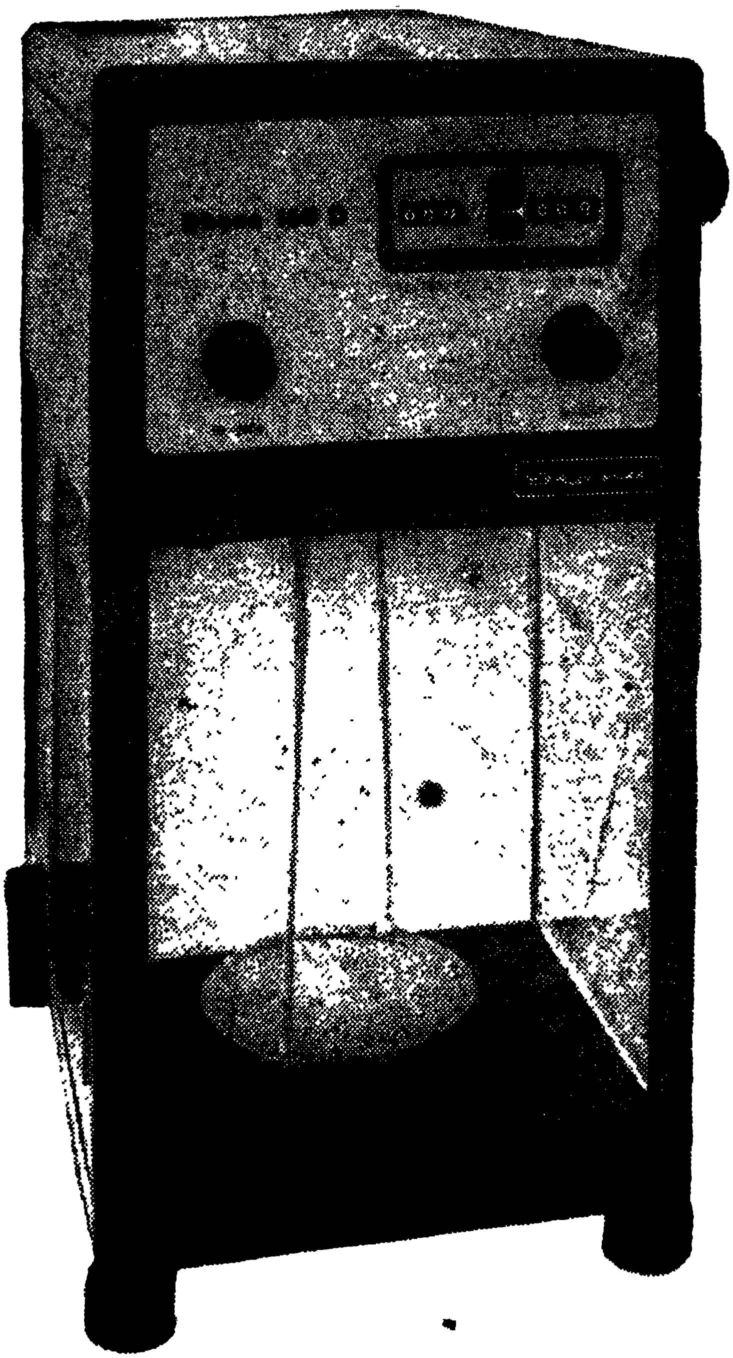

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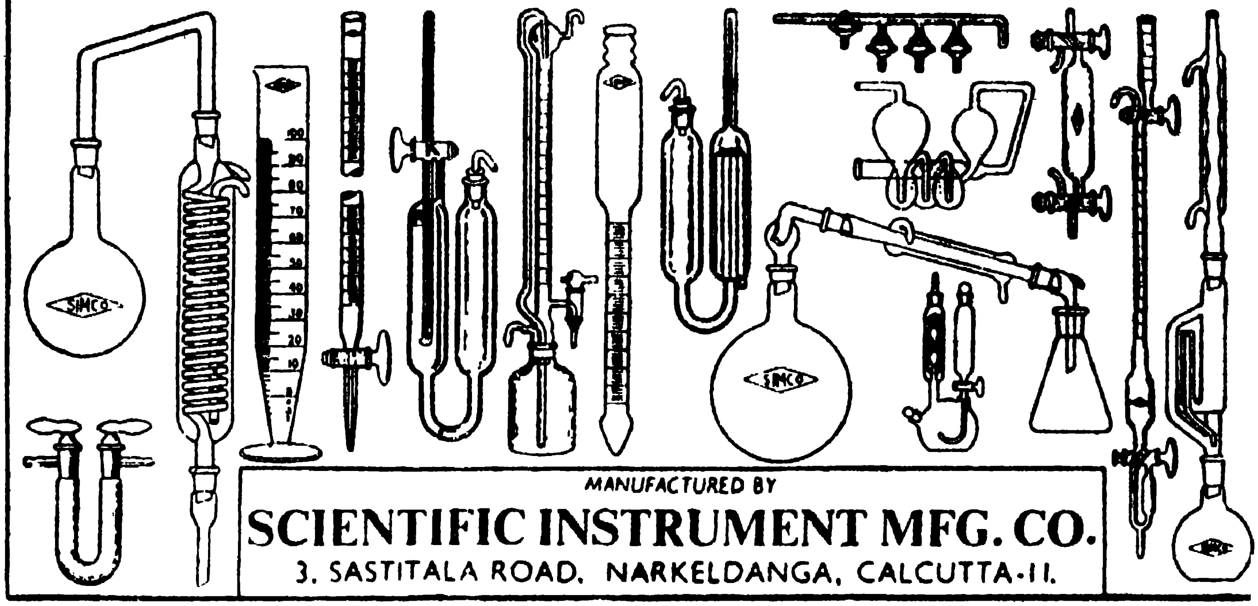

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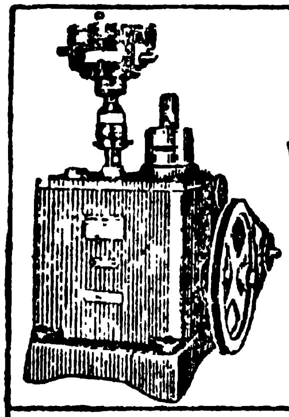

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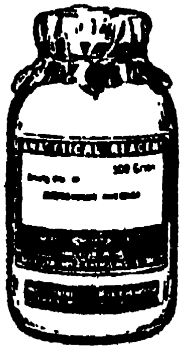

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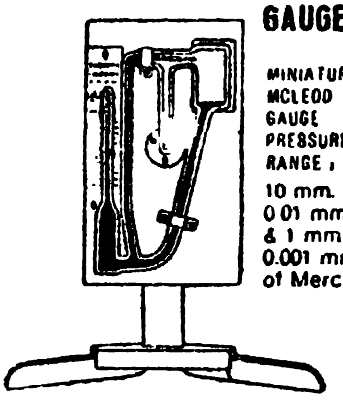

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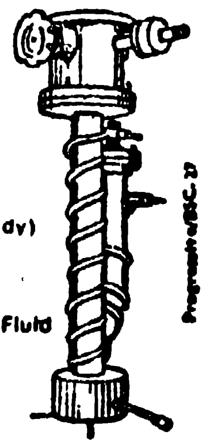

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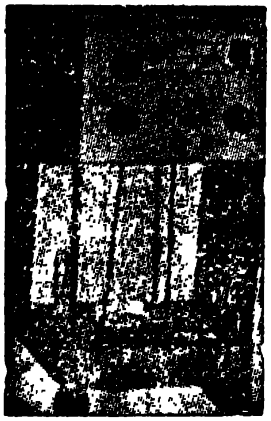

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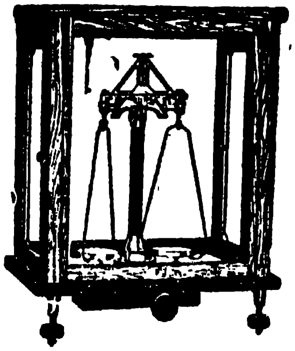

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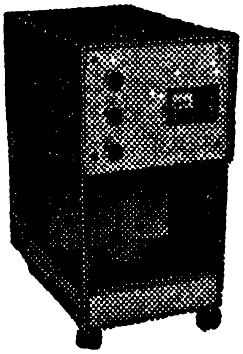

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CREDIBILITY AND ETHICS IN SCIENCE

SCIENCE is systematic knowledge; the purpose of scientific investigation is advancement of the boundaries of knowledge and its aim is establishment of truth. Hence, credibility and ethics go hand in hand in any pursuit of science. Infact, credibility and ethics are two of the most essential qualities of any member of a civilised society and this is more true of any one engaged in the scientific profession, since honesty is the foundation of the system of science. Deliberate falsification and fabrication of data is the worst sin in science.

Despite this position, however, fraudulent practice in science is not uncommon, and while this is known from the early days in the history of science it has assumed a larger dimension now commensurate with the rather explosive growth in scientific activity in the later half of the present century. This is evident from the fact that less than a year ago the American Association for the Advancement of Science (AAAS) held a conference to focus on research institutions' procedures for dealing with scientific misconduct in publishing/reporting data and findings which cannot be reproduced. A scientific honour society (Sigma Xi) of USA has published a book entitled "Honor in Science" which gives practical advice to the budding scientists encountering ethical problems in research. The Association of American Universities has issued a report on maintaining the integrity of research. In 1985, the editors of the journals published by the American Chemical Society (ACS) adopted ethical guidelines for the publication of results of chemical research. The Committee on Professional Relations of the American Chemical Society had a sub-committee on Professional Standard which has now been renamed as the sub-committee on Professional Standards and Ethics and given wider powers. Recently, this sub-committee has been assigned the responsibility to serve as a clearing house for ethical issues and problems of research misconduct.

Although outright and intentional fraud may be of rare occurrence in science, there are problems with less conspicuous but much more subtle forms of misconduct in scientific research which are of no less concern, viz. sloppiness, hasty conclusions based on unsystematic data and findings, lack of precision, self-deception, omission of data which do not conform to preconceived notions and preset hypothesis to smoothen the results, failure (often intentional) to acknowledge the source of an idea to claim originality, and even multiple publication of the same data. In fact, in a number of cases the same paper by the same group of workers has been published twice in some indian journals and this has been possible due to the extremely careless functioning of the concerned editorial boards. There are also cases on record where the discussion of some results is a verbatim copy of what appeared earlier in another journal without the earlier work being acknowledged.

In this connection it is worth mentioning that regarding a paper published by some Indian authors in *Science*, (133, 648, 1961), published from Washington D. C. (USA) the Editorial

Board of the journal came to know of an act of serious plagiarism and commented as follows : "..... Figure 3 in the same paper, which purports to be an original photograph, is a slightly enlarged copy of Fig. 1 in an earlier paper by Frenkel *(Ann. N. Y. Acad. Sci.*, 64, 215, 1956)". In an international conference held in India in 1979 an Indian author submitted a paper for a session of the conference which was almost a true copy of an abstract of a paper published earlier in a well-known international journal and as such it was not accepted; this was an accidental discovery of course. But despite this position, the concerned author and his band of supporters publicized that this was a case of victimization. He even succeeded in moving up the "ladder" quite fast to be promoted to a Professor's post in a prestigious institution with active support of the influential bosses whom he had patronized well by sycophancy.

The tendency for not acknowledging the works of others is a habit of even some of the most renowned scientists of the developed countries and numerous examples may be cited. Some of them even suffer from a false sense of vanity in acknowledging the works of even reputed and established scientific workers of developing countries. A case in point is that of a very stable compound of silver(III), first synthesised and studied by a well-known Indian chemist, which though reported in treatises like "Inorganic Syntheses", which publish results after actual checking and verification, has not been referred to in a comprehensive text book in inorganic chemistry written by a Nobel Laureate. Instead, in connection with discussion of the compound the reference of a much later work on the elucidation of its structure by physical methods by some western workers is only given and not that of the original synthesis by the Indian group. Some Indian workers are of course notorious in the act of wilful supresssion of facts and not acknowledging even the most well-known contributions of their colleagues elsewhere in the country; this they do with the ulterier motive to claim originality for their own contribution. There are also known cases of a paper sent for referring being held up by the referee and meanwhile the latter got something similar published in his name. It was in this context that we find the following in an editorial article published in the *Journal of the Institution of Chemists (India)*, (45, Part IV, 119-22, July, 1973) :

> "There is a subterranean complaint working amongst some authors of papers in the country on unethical work of the referees to whom the papers are submitted by the authorities of the journals for opinion on the suitability of such papers for publication".

In this article the author also mentioned about a paper being sent to a referee who after a very long time expressed that the paper was not suitable for publication. Later by an appeal to the Editor the paper was ultimately published but not before the particular referee had published a paper in his name covering the findings of the original author.

Such acts of piracy and plagiarism in science are indeed most lamentable. But strangely enough many such persons succeed in bagging some coveted awards and recognitions. In this connection the article published in *Nature* (London), (308, 581-600, April 12, 1984) on the impressions of John Maddox on Science in India is worth noting. In this the author had touched upon a number of crucial matters which require serious thinking. What this author said had been aptly summarised in an article published in the *Journal of the Institution of Chemists (India)*, (56, 111, May, 1984) as follows:

> "Publicity, politics, speeches, recycling of old ideas and false claims are smoothly operative for personal gain, and once the award is received it does not matter even if the fraud comes to light. Taking advantage of our environment of "ethics" the fellow smoothly moves up the steps of his ladder. The environment also encourages our scientists to become bureaucrats and the worst part of it is that thus giving up life of working scientists they continue to pose and are still accepted as top working scientists of the Country".

In fact, in India such so-called big scientists survive well due to lack of accountability and by having a group of stooges— the satellite scientists—who cling to them for undue favour and who survive at the mercy of those king makers in science. Any dispassionate and objective assessment of many of those who had been elected to the Fellowship of verious Academies in India, or who got some coveted prizes and awards, or who got elected to the offices of Sectional Presidents or even on the General President of the Indian Science Congress during the last two decades would amply prove this point. Examples are also there of persons been elected FNA only after being elected FRS. Indeed most of the Indian awards and recognitions have become mockeries as these hardly depend on the academic attainment and contributions of a person. Quite recently several persons have been elected FNA in a certain discipline in science despite their having hardly any worthwhile contribution, despite the work of some of them been criticized at the international level, etc. Even a physicist has been purposely cleared through the Chemistry Committee after being branded as a Chemists by the ruling coterie in violation of all norms and ethics. He has also been put into a chemistry committee of a Government Funding Agency at the pleasure of an influential person—one of the so-called "Dada" in control of scientific affairs in this country; in fact, he has his stooges in many such committees so that he can easily fulfil all his wishes including disbursing favour of all sorts to his favourites.

Such organised unethical practice and daylight robbery in science are almost unknown in most other countries; it was also less prevalent in our country even a few decades ago. But sadly enough the conditions have deteriorated rather fast.

In contrast, we find the case of a Columbia University Professor in USA, withdrawing three of his communications from the Journal of the American Chemical Society, because parts of the work could not be reproduced. What is even more striking is that after a preliminary enquiry, the Columbia University authorities had set up a committee to investigate the possibility of scientific fraud. But even genuine complaints of a serious nature regarding even gross acts of favouritism and nepotism and denying even the minimum rightful dues levelled against the king makers in science in this country are hushed up or go unattended. This is so much demoralising and it has vitiated the scientific temper of the community to such an extent that conditions are far from being conducive for science to develop; since in this situation even most competent persons hardly get the incentive and inspiration for any productive work of quality. Indeed, in a state of uttar frustration many switch on to the cheaper and easier methods of obtaining gains by being sycophancts and ciphers of the influential people in a give and take policy. The present-day conditions in India are such that people engaged in grave unethical practices are not considered unethical, but those who try to point out the same are branded as unethical. Infact, at the meeting of the Council of the Indian Science Congress Association held during the annual Congress of the association at Calcutta in January, 1962 a small committee of two renowned Indian scientists was formed to prepare a note on the subject of ethics and code of conduct in science. But despite this pious resolution nothing tangible was done for any remedy; indeed the conditions now are worse than those of 1962. The reason is simple, the "Ghost is within the mustard itself". The situation has been aptly described by the author of an article published in the *Journal of the Institution of Chemists (India)*, (43, Part IV, p. 135, July, 1971), a relevant part of which is quoted below:

> " . . . . . unjustified claims, overclaims and passing others' results as one's own are becoming an infectious disease amongst scientists in the country specially in view of the high premium it is yielding with regard to securing big jobs, positions of honour and awards. A serious scientist absorbed in his research finds it difficult to develop the taste for going round authoritative persons, and but for his scientific contribution loses considerably though he may be very strong in

> his little corner, while another proceeding along the above alternative track finds it much more convenient to secure all the laurels".

The author further suggested setting up of an authoritative body to enquire into all such cases to curb the trend. But knowing the conditions as they are in this country to-day, this hardly seems to be the solution; the persons who will have easy access to any such committee or commission will have to be corrected first.

Numerous instances are there which lead one to believe that persons of questionable integrity and scientific morale easily get all sorts of awards and recognitions and also become decision makers in the existing set-up in India. In fact many such unscrupulous people enjoy undue privileges as long as they live, but only in some extremely rare cases such a person may get exposed later in his life as it appears to have happened with a person enjoying the status of a coveted Emeritus Professor of a University in Rajasthan who has recently been deprived of all the privileges of the Emeritus position after some unscrupulous past records became known due to the efforts of some of his adversaries. But in India to-day this is a rare event, not only in science but in all other spheres. Thus, despite the Central Government's professed policy to eradicate corruption a senior member of the central cabinet was hounded out of the party and the Government because of his taking positive actions in fighting out corruption and there is a tendency at the highest level to hush up matters and thus protect the offenders. The same is very much true of those in control of scientific policies and activities in this country to-day.

The line of demarcation between error, sloppiness and self-deception on the one hand and deliberate fraud on the other is rather difficult to draw. Minor infringments are really quite common than deliberate fraudulent results. Although many may not consider this as fraud, they can be very damaging to the scientific community and integrity of scientific efforts. Such unreliable data finding their way into the scientific literature may do a lot of harm such as huge wastage of time, resources and energy of future workers in attempting to separate the cream out of water.

There are three major stages in the dissemination of new knowledge and safeguards are needed to catch misconduct at each stage. The first is of course the laboratory itself where high standards ought to be maintained to prevent the outflow of unreliable data. The second is at the publication stage where editors and referees judge the quality of a contribution. The third is of course replication by which others attempt to confirm or disprove the findings of earlier workers. But there are big loop-holes at each of these stages through which incorrect and/or unreliable data may find their way into the world's stock of knowledge.

The first line of defence is the laboratory where the results are gathered. Actually, no result is expected to be published unless the workers have scrupulously scrutinized and reconfirmed their findings with extreme care and caution taking fully into account the degree of reliability of the observations; for an experimental work this largely depends on the inherent degree of precision of the instrument(s) used. A lack of understanding of this is often the cause of unreliable data coming out of many laboratories in India and possibly also in some other countries. However, in the existing set-up a research scholar is under a constant pressure to publish quickly to have a renewal of his tenure and for being promoted to a senior position. The same pressure is also there on faculty members who are under the constraint of the traditional axiom "publish or perish". As a result of this pressure to publish, most often many scientific workers publish their results without exhaustive and critical scrutiny. Moreover, senior persons having a variety of other responsibilities guiding and supervising the work of a fairly large group of young people cannot check everything that a student/coworker reports. Hence, to prevent or at least minimize the chances for unreliable data leaving the laboratory, the group leader should try to first inculcate in the young researchers the necessity for being extremely critical and objective in scientific investigations and a respector of values including ethics in all form. They must learn not to suppress facts, or disown the contributions of others, and must share responsibility and accountability for the reported results.

In the case of a fairly large research group it is impossible for the group leader to know precisely what is going on with each individual. Frequent group discussions and open seminars help a lot in such cases to minimize erroneous data flowing out. Unfortunately this situation does not exist in most places in our country. There is very little pre-publication exposure which can largely reduce chances for fraudulent publications. It is also important for a group leader not to be too excited about positive and anticipated results and feel only depressed when the results are unexpected or even negative. In the words of Michael Faraday "The scientist should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biased by appearances; have no favourite hypothesis; be of no school; and in doctrine have no master. He should not be a respector of persons, but of things. Truth should be his primary object. If to these qualities be added industry, he may indeed hope to walk within the veil of the temple of Nature".

As mentioned earlier, the second stage is the publication stage when the results of a research work are submitted for publication. Here, the Editors (if they are really competent) and the referees have a chance to screen and reject substandard materials. However, at this stage one can hardly catch fraudulent data. They are expected to judge the logical consistency, soundness of conclusions and the importance of the results. Surely, it is not feasible for them to recheck every experiment or calculation. Referees mostly work with the basic assumption that the author(s) are honest and scrupulous in reporting their results. However, a competent and knowledgeable referee should be able to ensure that a work is not a mere repetition of an earlier one by another group but unacknowledged in the present work. Due to huge proliferation of scientific literature this is also not quite easy to ensure particularly in cases of previous results published in some less well-known journals.

The presently growing tendency to publish short communications rather than full papers is also a potential threat to the infalliability of scientific literature. In such short communications experimental details are always missing and hence it is quite easy for honest self-deception or even genuine fraud to slip in. Very few indeed bother if the dirty linen is not to be exposed to the public. It is, therefore, better not to accept a short communication for publication unless some essential basic details and information are incorporated in the communication.

The third stage, which is the ultimate safeguard in science, is replication. However, very few publications do face such a challange, since there is little gain to a research worker by merely disproving some one else's work excepting in some very special situations.

Maintaining the integrity of science and at the same time remaining fair to the individual should be the responsibility of every scientific organisation and society. Ultimately, scientists must take the fullest responsibility for maintaining integrity and uphold ethics in science. Unfortunately, such an environment is sadly lacking in the country to-day due to uncanny, over ambitious and selfish motives of many of the members of the scientific community. In their effort for an empire building and self aggrandizement they wilfully compromise in matters of virtues and values and thus lend support to immoral and unethical practices out of vested self-interests. □

D. Banerjea

MENTALLY RETARDED WITH SPECIAL REFERENCE TO EPILEPSY*

ASIMA CHATTERJEE**

AT the outset I would like to thank Professor P. K. Bose, President, Indian Science News Association, former Pro-Vice-Chancellor Academic, Calcutta University and Professor S. N. Ghosh, former Sir Rashbehary Ghosh Professor of Applied Physics, Calcutta University, and presently Senior Scientist, Indian National Science Academy, New Delhi, for inviting me to deliver the Santanu Ghosh Memorial Lecture. Santanu was the eldest son of Professor S. N. Ghosh. He had suffered from nephritis since his childhood. Though he suffered from kidney ailments very often, which compelled Santanu to be confined to bed, he was never perturbed. He loved to study scientific literature and personified himself with science. He had great enthusiasm for scientific discoveries and inventions and spent most of his time with books on science. His flair for scientific modelling and his keen interest in assembling and repairing various machines developed when he joined the science stream of the Higher Secondary Course after passing the Secondary Examination. He had diverse interests. He was interested in oil painting and spirographic art. Collecting records and tapes was his hobby. He loved music. The songs of Rabindranath, Rajanikanto and Atulprasad inspired him till the last days of his life.

Santanu calmly faced all the sufferings of nephritics and accepted his fate with boldness, courage and determination. On 31st of July, 1979, he went to the hospital, never to return.

Santanu's father, Professor S. N. Ghosh has instituted a lectureship to commemorate his memory I gratefully accept this honour to deliver the second Santanu Ghosh Memorial Lecture. The topic that I have selected for this second Santanu Ghosh memorial lecture is "Mentally Retarded with special reference to Epilepsy". Epilepsy is a social problem which is a matter of grave concern throughout the globe.

The Indian Council of Medical Research undertook a Survey of physically handicapped and mentally retarded in India and in 1971 they reported that (1) 30 lakhs of population were mentally retarded, (2) 90 lakhs were physically handicapped, (3) 40 lakhs were deaf and dumb and (4) 60 lakhs were blind. Since 1971, the total population in India has increased by 20% and therefore, we have to consider for social security at least for 2.5 crores population of handicapped or mentally retarded. This is a very important and urgent issue of the day as neglect in social security of these handicapped or retarded is causing anguish and loss of peace to the families of 4.5% of total population every year.

It is not possible for any individual to deal with these problems. That is why the W.H.O. has a Social Security Department which is trying to deal with the above problems in different countries by coordinating Departments of Health, Education and Social Welfare.

Behavioral disorders in the mentally retarded as well as other groups of handicapped have attracted the attention of sociologists, anthropologists, psychologists, psychiatrists and educationists in general. In this particular field the rehabilitation programme cannot be generalised as the pattern of behavioral disorders varies from individual to individual. However, it is being realised that if from birth such disorders can be diagnosed or possibilities of such can be detected and treatment is instituted early, subsequent management or rehabilitation is feasible.

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*Second Santanu Ghosh Memorial Lecture held on 17 August, 1987, under the auspices of Indian Science News Association.

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There is considerable improvement in the behaviour and the possibility of becoming grossly crippled is much less.

Mentally retarded cases are mainly of three categories : (1) mentally retarded only , (2) spasticity with retarded cases with or without epilepsy, (3) epilepsy with mentally retarded cases of varying degrees. In all the groups, behavioral disorders can be rectified considerably if the history of the case is properly studied.

As the treatment of such disorders is now directed to bring the retarded child under the rehabilitation scheme extensive searches are being made in the plant kingdom by chemists, ayurvedic physicians as well as modern medical scientists. Indigenous medicinal plants are being considered as probable remedies. For over twenty years my department and my research staff and myself are actively associated with such approach to the treatment of epilepsy and mentally retarded.

Epilepsy was known in ancient times to be the effect of an attack by an evil spirit. Though physicians long before the time of Hippocrates, suspected epilepsy as a disease, the recognition of epilepsy as a clinical entity was due to Hippocrates. In his writings there is clear presentation of observation regarding this disease which formed the basis of medical teachings throughout the middle ages. The first scientific monograph on epilepsy, entitled "On the Sacred Disease", is a classical treatise dealing with these ancient beliefs and it is described there as a disease of the brain due to natural and not supernatural causes.

Epilepsy[1-4], as it is recognised now, is defined as a chronic clinical disorder or a syndrome characterised by recurring paroxysmal attacks or fits in which consciousness is lost or impaired in varying degrees with or without succession of tonic or clonic muscular spasms. It may appear at any age but generally has its onset most frequently in early childhood. Individual seizures of fits vary in severity from almost imperceptible, momentary lapses of consciousness or mental clouding to violent generalized convulsions lasting for several minutes.

Epilepsy according to the W. H. O. dictionary is a neuropsychiatric problem with brain disorder of various etiologies characterised by recurrent seizures due to excessive discharge from cerebral neurons associated with a variety of clinical and laboratory manifestations. John Houghlings Jackson (1834–1911) gave the modern concepts and correct interpretations of epilepsy on scientific basis.

Jackson had firmly established that epilepsy is a case of mental retardation arising out of abnormal functions in the brain. Brain is a complicated electric cell. Normal biochemical reactions of the brain cells produce electric waves of 10-100 cycles/second. Any increase or decrease in the biochemical activity of the brain results in an irregular out of phase discharge from neurons (nerve cells) that cause their hyperexcitability resulting in epiletic convulsion usually designated epileptic attacks. This is probably due to the generation of short circuit in the brain due to the disturbances in normal biochemical pathway.

A working classification has so far been used by the clinicians from therapeutic point of view to decide whether patients have attacks that arise in the cerebral cortex i.e., focal cerebral seizures or in a subcortical region i.e. centracephalic seizures, and the third type that arises from unlocalised areas of brain as a result of diffused abnormality i.e. unlocalised cerebral seizures.

Jackson's proposal that epileptic attacks are caused by "occasional, sudden excessive, rapid local electrical discharges of gray matter of the brain" has been substantiated from the studies of the changes in the normal brain wave patterns. The changes can be detected by a sophisticated instrument termed the electro encephalograph. In case of epileptic patients the encephalograms do not exhibit normal brain waves pattern. Epilepsy has been broadly classified into four categories Petitmal epilepsy, Grandmal epilepsy, Jacksonian epilepsy and Partial epilepsy (Psychomotor).

(i) *Petitmal epilepsy* : In such cases EEG exhibit fast waves with a burst of heavy electrical discharges which stop before consciousness is lost. If consciousness is lost it just continues for 5-20 seconds.

EEG exhibits alternately slow and fast waves and generalised rhythmic spike.

(ii) *Grandmal epilepsy* : Seizures accompanied by general convulsions, chewing motions and loss of consciousness. Due to heavy neuronal discharges which spread throughout the CNS system (Cortex, lower part of the brain and the spinal cord) tonic convulsions are observed followed by clonic convulsion. EEG shows fast brain waves Electric rhythm is of increased rate and high voltage.

(iii) *Jacksonian epilepsy* (Focal Epilepsy) : Discharges are localised without loss of consciousness and *EEG shows high frequency*.

(iv) *Psychomotors seizures* : Consciousness is not lost. This is characterised by an attack of abnormal rage, sudden anxiety and a moment of incoherent speech.
A typical *EEG shows a low frequency*.

At the onset of seizures (epileptic attack) the patients may have the following sensation:

Heaviness and giddiness in the head
Tension in the eyes
Ringing in the ears
Dim vision
Bad odour and bitter taste and
Pain in abdomen
(These symptoms are called Auras due to sensory, motor and psychical changes).

During attack the patient
becomes Dumb and
Insensible to space, sound, sight and pain
Smiles, unaccountable due to extraneous cause
The body is twisted from all sides with clonic and tonic jerks, Fists and teeth are clenched
Eyes and mouth are distorted
with copious salivation and foaming from mouth, and
Difficult breathing (Dyspnoea) leading to loss of consciousness.

For the effective treatment of the disease which results due to the malfunctioning of the central nervous system it is necessary to study the etiology of epilepsy and to find out the causes of this malfunction. Investigation so far carried out in this field have shown that epilepsy may be idiopathic or non-idiopathic (Table 1).

TABLE 1

Idiopathic	Non-idiopathic (cause not known)
(i) Congenital defects	Normal metabolism, i.e. normal biochemical reaction is disturbed and a proper balance between excitation and inhibition of brain activities is lost leading to the disruption of interlinked nervous system in the nerve network. This leads to a short circuit resulting in epileptic convulsions Radiological, angiographic and brain-scan investigation does not reveal any abnormality. Recently studies in cerebral blood flow and positron emision tomography (PET) have shown that epilepsy is not due to any definite morbid lesion in brain. It is caused by abnormally active brain tissues resulting from injury, infection or from unknown agents.
(ii) Head trauma e.g. blood clot in the brain	
(iii) Neoplasm Brain scan in such cases is of considerable diagnostic value	

Epileptics have an epileptogenic focus i.e. , some of the nerve cells, if not all exhibit hyperexcitability, i.e., the threshold of neuronal excitability is much low. Low threshold systems are to be considered as the causative factors. These cells under excitable conditions caused by exteroceptive or interoceptive stimuli, trigger a volley of nerve impulses transmitting to the normal neurons. Due to this bombardment of neuronal activity at high frequency normal neurons get excited with the spreading of abnormal neuronal firing from the focal area to other parts of the brain.

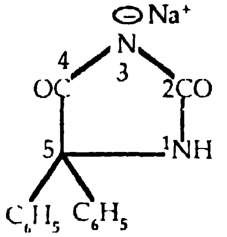
The basic principle of therapeutic management will be

to restore the hyperexcitable state of the nerve cells or neurons to the normal state (normal functional level), avoidance of exteroceptive (vision/hearing /pain/touch /temperature) and interoceptive stimuli (heart, blood vessels and viscera which have their tone primarily myogenic but influenced by the autonomic nervous system) may throw the hyper-excitable system into seizure activity, and re-establishment of the interlinked system of the different organisation of the nervous system.

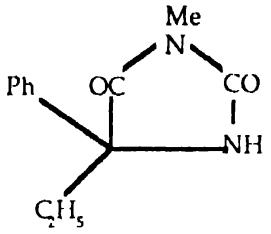
The effective treatment needs the restoration of normal biochemical pathway. For the purpose, besides drug administration, mental rehabilitation in adjunct with psychotherapy is necessary to help the neurons to regain normal activity.

Synthetic drugs which are frequently used for the treatmet of Grandmal, Petitmal, Psychomotor and Jacksonian Epilepsy are shown in Figs.1-4.

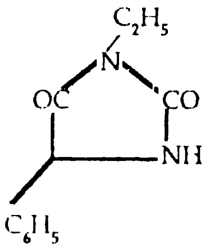
Drugs for the Treatment of Grandmal



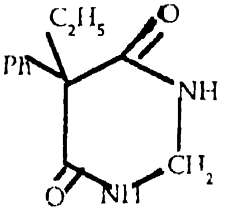
Phenetoin sodium
(Dilantin)



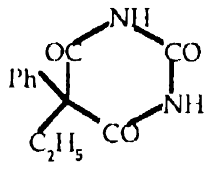
Mephenytoin
(Mesantoin)



Ethotoin
(Peganone)



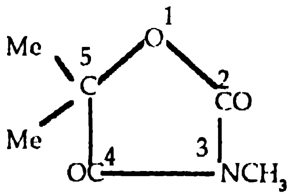
Mysoline
(Primidone)



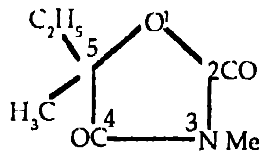
Phenobarbital
(Luminal)

Fig, 1

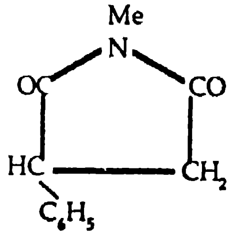
Drugs for Petitmal



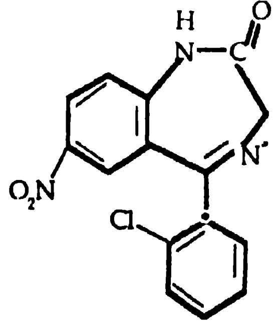
Trimethadione (Tridione)



Paramethadione (Paradione)



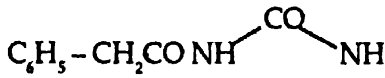
Phensuximide (Milontin)



Clonazepam (Clonopin)

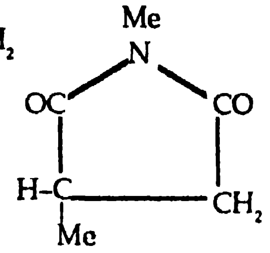
Fig. 2

Drugs for Psychomotor Epilepsy

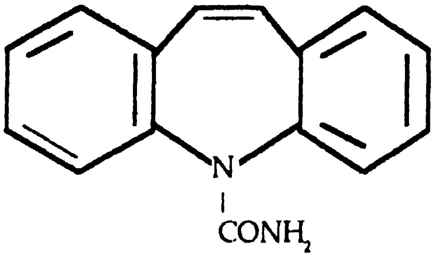


$C_6H_5-CH_2CONH\overset{CO}{\frown}NH_2$

Phenacemide
(Phenurone)



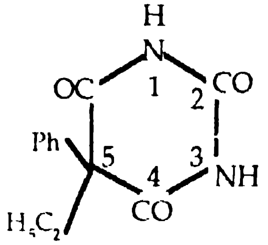
Methsuximide
(Celontin)



Carbamazepin
(Tegretol)

Fig. 3

Drugs for Jacksonian Epilepsy
(Cortical Epilepsy)



Phenobarbital (Luminal)
Fig. 4

These synthetic drugs are highly toxic. They produce (a) Gum hypertrophy (b) Ataxia (c) Pancytopenia (d) Severe skin eruption (e) Bone marrow depression (f) Nephrosis (g) Photophobia (h) Hepatitis (affects liver function) (i) Diplopia (j) Psychoses (k) Mental dullness (l) Haematuria (m) Anorexia and (n) Insomnia.

Other undesirable effects are also observed e.g. personality changes, drowsiness, irritability, nausea and vomiting.

In some cases drug resistance also develops. Due to toxic effect it is sometimes necessary to withdraw the drugs but the withdrawal of the drug heavily precipitates the seizures.

Thereby an intensive search was made to discover efficacious drugs from the plant kindgom. After intensive search it was possible to discover drugs from herbal sources, the most effective being marsilin (Fig. 5) from the water fern—*Marsilea minuta* (vernacular name: Sushuni).

Major Chemical Constituent of *Marsilea minuta* Linn.

$$C_{25}H_{51}COOH + C_{29}H_{59}CH_2OH$$

(Hexacosanoic acid) + (1-Triacontanol)

$\uparrow$ Hydrolysis

$$C_{25}H_{51}COO\,CH_2C_{29}H_{59}$$

Marsilin

Fig. 5

Further investigation revealed that suitable medicinal preparation of combined drugs from Sushuni [*Marsilea minuta* Linn (Marsileaceae)] and Brahmi [*Bacopa monnieri* Linn.(Scrophulariaceae)] or Sushuni and Jatamansi [*Nardostachys jatamansi* DC. (Valerianaceae)][7-9] (Fig. 6) are much more efficacious than the single herbal medicine. Crude extracts of these plants show remarkable therapeutic effects in epileptics and are better than the pure components. The enhancement of the drug activity in such cases is due to synergestic action of the components other than active constituents occurring in plant cells.

Major Chemical Constituents of Nardostachys Jatamansi

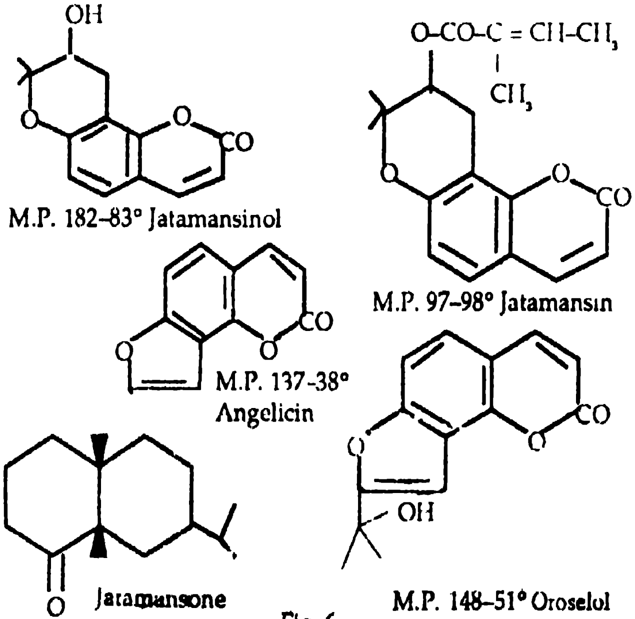


Fig. 6

The chemistry of the major chemical constituents of *Nardostachys jatamansi*[7-9] and *Bacopa monnieri*[10] have already been reported. A comparative study of herbal medicine and synthetic drugs has been made (Table 2). It would be seen that the former is much better than the synthetics, so far as the health hazard are concerned.

TABLE 2 : Comparative studies on Herbal Medicine and Synthetic Drugs

Herbal Medicine	Synthetic Drugs
Marsilin and combination of the concentrated alcoholic extracts of *Marsilea minuta* (Sushuni) and *Nardostachys jatamansi* (jatamansi) or *Marsilea minuta* (Sushuni) and *Bacopa monnieri* (Brahmi)	Phenobarbitone, Melleril and Mysoline, Epotoin and Mesantoin
1. Anticonvulsant	1. Effective in controlling fits
2. Non-toxic	2. Toxic
3. Effective in alleviating the mental and behavioral disorder of epileptic patients besides controlling fits.	3. Diminish the behavioral disorder to some extent
4 "Withdrawal Phenomenon" is not observed.	4. Withdrawal effect is serious Violent fits precipitate. Behavioral disorder reappears.
5. Spike discharge and "abnormal slow waves" (2-4 and 4-6 cycle/sec.) gradually disappear.	5. Suppressive Drugs.
6. No change in personality.	6. Change in personality.

Besides the treatment of the epileptics with herbal medicine therapeutic management emphasises the implementation of mental rehabilitation programme, environmental change and occupation according to the preference of the patients The scenario in the environment very often irritates the epileptics. Thereby mental rehabilitation and even removal from their residence to mental homes is necessary. Besides, they must be kept engaged with suitable jobs to their satisfaction. For this purpose the patients should be kept under the supervision of the psychiatrists and psychologists who on careful psychoanalyses would be able to find out what particular job would be suitable to them and also whether they would be satisfied with the nature of the job.

Thereby not only therapy with herbal medicine but also mental rehabilitation, occupation therapy and environmental changes are necessary to restore the normal function of the brain and keep the epileptogenic focus undisturbed thereby preventing the provoking of hyperexcitable neurons and maintaining peace of mind.

It needs mention in this connection that although herbal medicines may take time to produce perceptible effect on the patient, they are definitely better than synthetic drugs on a long term basis.

From the extensive clinical trials with the epileptics using herbal drugs it has been established that epilepsy is a neuropsychological and neuropsychiatric problem. Epilepsy is characterised by (a) Epileptic fit and (b) Quiscent period during which behavioral and/or psychological changes could be observed.

While concluding it may be stated that marsilin or the combined drug (p. 146) has a definite influence on the metabolism of the brain. These chemicals probably influence GABA metabolism and control the synthesis, storage and destruction of serotonin and other monoamines in such a way so as to correct the short circuit in the brain which is responsible for hyperexcitability.

As rehabilitation programme is an essential paripassu it may be concluded that herbal products are important for the rehabilitation therapy for helping in reconditioning the brain. □

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ROLE OF STATISTICS IN NATIONAL PLANNING AND ECONOMIC DEVELOPMENT*

P. K. BOSE**

Introduction

Professor P. C. Mahalanobis has explained in a lucid way the use of Statistics in planning and further he has demonstrated its importance in planning while formulating the Second Five Year Plan.

National planning has several aspects. First there is the preparation of plan at the technical level where the co-operation of workers from the different areas of S and T is required. Statistics is essential at this stage for the supply of correct information. Secondly the individual plans have to be built into a general plan. Here also Statistics is the common denominator and supplies the common binding medium for the whole. Thirdly the plan has to be implemented. At this stage Statistics can help in two ways. Firstly by establishing controls to ensure the programme of action proceeding on efficient lines. Secondly by conducting continuous assessments of results by keeping account of the input of money, effort and resources and measuring what is obtained in return. This is a continuous process. In working of the plan, defects are revealed and new possibilities emerge requiring consequential changes. Statistics is again invaluable in diagnosing weaknesses, in guiding controlled experiments and in suggesting improvements. Statistics is thus an integral part of the dynamics of national planning.

Statistics had its origin from the collection of information relating to social and economic conditions of the people, its help in making policy and administrative decisions. In every country it may be noted that whenever there has been an upsurge of social political and economic activities there has also been a rapid advance of Statistics. A few instances may be cited. In our country, Maurya period reached its peak in the time of great Asoka and Arthasatra of Kautilya claims to date from this period 321-296 BC. The detailed description of contemporary industrial and commercial practice points to a highly developed Statistical system. Instructions are given about the classification of villages. Specific decisions are given for a detailed census of land and field. It is the duty of Gopa, village accountant to attend to the accounts of five or ten villages as ordered by Collector General. One striking feature in the Arthasastra is the emphasis on the need of checking and verification by independent agents working in secret without the knowledge of the original enumerators.

Nearly two thousand years later in 16th century, in the time of great moghal emperor Akbar, we find again a very elaborate system of Statistics in the comprehensive survey of the country called *Ain-i-Akbari.* The *Ain-i-Akbari* gives a detailed administrative and statistical account of India as it was about 1590 A. D. Under the great emperor Akbar. In *Ain* is given a detailed account of the classification of land based on yield of crops. A distinction is made between yields in two seasons 'spring harvest' and 'autumn harvest'. *Ain-i-Akbari* gives the area, revenue valuation, strength of army and other details for about 15 Subhas (Provinces) comprising over 120 Sarkars (Districts) and over 3000 mahals (townships and subdivisions) extending from Assam and Arakan to Afganisthan.

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In the British Period in India, at the time of renewed country wide economic activities there were great advances in Statistics of which one striking example was the survey of East India by Francis Bechanan in the first decade of the 19th century. During the last 40 years since independence there has been a great deal of expansion of Statistical activities in India.

Part I : Statistics in National Planning and Development

Here I will discuss in brief the use of Statistics in national development. The real object and justification for collecting Statistical data is to use this information to make policy decisions i.e. to choose that particular programme which is likely to serve most effectively the purpose in view. Statisticians have to perform a four fold task. Firstly to conduct properly organised surveys for collection, analysis and appreciation of relevant Statistical data. Secondly on the basis of such information, to help in the choice of an efficient programme of action. Thirdly when the plan goes into operation, to measure the progress of work and to assess the results achieved. And finally on the basis of such assessment either to report that the work is proceeding as desired or not. If not, the plan itself may have to be modified. In this way the four step cycle *Formulation—Implementation—Monitoring—Appraisal would continue throughout the plan period.*

Statistics can be used both in a strategic and in a tactical manner i.e. either to decide questions of overall economic policy and programme or for developments in specialised sectors. I shall discuss the use of Statistics in important sectors of economy.

(a) *Design of Experiments for Higher Productivity*

The aim of science and practice of agriculture is to increase crop production by using better seeds, better methods of cultivation including use of better water management. This has actually happened in India. In the agricultural field before 45 years the country used to import rice from Burma, wheat from Europe and cotton from Egypt. The food grains output has over this period trebled from 50 million tonnes to 150 million tonnes and the spectre of famine which dominated the economy in fifties no longer exists. Statistics has played a significant role in this achievement. A most significant development in modern Statistics took place when R. A. Fisher introduced the technique of 'design of experiments' which increased the precision of field trials. A simple illustration may be helpful.

The fertility of the soil varies sometimes widely from one part to another within even a small plot of agricultural land. If the plot is divided into a number of strips and a different variety of rice is sown in each strip it is quite possible that a really better yielding variety would sometime give a much lower yield than an inferior variety simply because the former happened to have sown on a strip of land in which the soil fertility was exceptionally low while the inferior variety was sown by chance on a patch of soil which was particularly fertile. Unless differences in soil fertility can be eleminated no reliable conclusions can be drawn as to which variety has a really higher yield. After many decades of agricultural field experimentation there was a complete dead lock by about 1920 it seemed that further progress was not possible. It was Fisher's genius to show how, by a very simple change in the lay out of the experiment it is possible to eleminate the effect of soil differences and draw conclusions with scientific validity and high precision. The logic of Fisherian design is very simple. In pre Fisherian experiments a plot of land would be divided into say 4 strips each of which would be sown with 4 varieties of rice. In the Fisherian design each of these 4 strips is divided into 4 plots forming 4 columns and 4 rows with 16 plots in all. The varieties are then sown in such a way that each variety occurs once and only once in each column and in each row of plots. Each column (and each row) now has all 4 varieties so that total yield of each column (or each row) now become strictly comparable so that soil differences, if any, can be detected and eliminated in an objective manner. Also instead of yield of single strip the yield of 4 plots of each variety is now available which makes it possible to calculate the margin of error of the estimate in valid manner.

The design of experiments has been gradually extended to scientific and technological experimentation of all kinds and has added a powerful new tool in the hands of the scientific investigation.

The much higher level of precision attended in the Fisherian design of experiments made rapid developments possible in the breeding of new and improved varieties of plants. In the case of wheat in India amazing results have been obtained. The yield was improved to such an extent that money value of additional production of wheat is of the order of several millions of rupees every year. With the help of new Statistical tools fundamental genetic researches have lead to an equally startling in the yield of rice, which will have important repercussions on national development in India.

(b) *Large Scale Sample Survey for Plan Formulation and Assesment*

I shall now refer to a general method namely the use of Statistical Sampling which has been practised from the beginning of human history. It is however only during the last five decades that serious attention is being given to the use of Statistical Sampling on a large scale for the collection of social and economic information of all kinds and significant developments have taken place in the design of smaple surveys.

In agriculture, public health or social and economic studies Statistical methods are increasingly used. In practically all situation in which we have to be made almost invariably by the method of sampling method. With the growing complexity of human society, scales of operation are rapidly increasing in size. In application to practical problems the sampling method has to be used often on a very extensive scale. This has assumed great importance especially after the introduction of planning process.

The underlying principle is simple and familiar. The real task is to give it practical shape. Firstly to attain results with precision and secondly to do this at a cost which will be reasonable for the practical advantage secured. Sample surveys must be made to work on a large scale under actual field conditions. This requires not only Statistical theory but organisational skill in handling human material and the ability to circumvent physical obstacles. Team work is particularly important. Proper designing is as important in Sample Surveys as in agricultural and other experiments. The fundamental aim is the same in both cases namely to collect the maximum information with the least possible expenditure of time and money. But the approach and the type of the design is naturally different in two cases. In large scale sample surveys the work of planning broadly falls into two stages namely the exploratory and the final. The aim of the exploratory stage is to collect basic information required for preparing the final plan. In large scale survey the question of expenditure is of decisive importance. This is why a study of cost function assumes a special importance of its own. The theory of stratified sampling is appropriate only when the cost of collecting the information for any number of sample units is independent of the manner in which these sample units are distributed over the field. This however rarely occurs in practice in large scale surveys. It was found that the cost was profoundly affected by the geographical distribution of sample units. This means that principles other than stratification are necessary for securing an efficient sampling technique. It is usually possible to split up the cost function into a number of independent components each of which can be studied separately. Fields which in nature often lie between two extremes that is, they are neither of a purely random nor of a completely patterned type. In such cases the variance function will be determined by the type of field. This is why a study of random and non-random fields and associated variance functions is of great importance in connection with the design of sample surveys. Many considerations both

Statistical and organisational have to be kept in mind in preparing the actual design of the survey either in case of its exploratory stages or in its final form.

Sir John Hubback was the first person to consider random sampling for estimating crop areas but he did not use it in practice. His own work was concentrated on Statistical Sampling for the yield of rice in Behar and Orissa in the early 1920's. His original report was reprinted in *Sankhya*, Vol. 7, pt 3. On the initiative of Mr. Townend, Development Commissioner Bengal, a sample survey on an area basis was conducted over the whole province of Bengal in 1935, the improvement of the jute fore-cast. This was the first area—sample in the whole world. Professor P. C. Mahalanobis was involved in this work. A little later the Indian Central Jute Committee approved a five year Scheme for a sampling method for the jute crop in Bengal. This work was entrusted to the Indian Statistical Institute. Work was entrusted to the Indian Statistical Institute. Work was started, under the leadership of Prof. Mahalanobis, on a very small scale in 1937 and an efficient sampling plan was developed by the Institute by a series of annual surveys, on a gradually expanding scale, until the whole province was covered in 1941. A complete account of 'Large Scale Sample Surveys' as developed by Professor P. C. Mahalanobis has been published by Mahalanobis trust in 1987.

(c) *Data Base for Planning*

With the attainment of freedom the full impact of the large gaps in the Statistical information available in our country was felt and an urgent need arose to tone up its quality and quantity. At the instance of the Prime Minister Jawaharlal Nehru, Prof. P. C. Mahalanobis prepared an abstract scheme of organising a National Sample Survey (NSS) which was approved in principle by the Government of India in January 1950. At the beginning the planning and execution of NSS was mainly entrusted to the Indian Statistical Institute but for the last two decades it is functioning under the ministry of Planning.

The NSS is intended to supply a continuing stream of information about social and economic conditions over the whole of Indian Union to the Government and to the Planning Commission. In the first round of the field survey (which began in 1950) about 240 investigators visited about 1800 sample villages (selected in a suitable random manner from all over the country, uptil now about 40 rounds of survey have been completed. Attempts are being made from the very beginning to cover the whole of the house hold economy and cottage industries. Information is being collected about the production of crops and live stock, hand industries, consumption of food and clothes and other items of consumer goods, improvement of lands, construction and maintenance of buildings, increase of implements and means of production, trade and transport, professional services, prices and wages etc. In addition demographic and other social Statistics are also being collected. The above list indicates the wide rage of data base which is available in India. For national planning this basic information is essential. A field staff of about 500 trained whole time workers are posted in sample villages and towns covering the whole country. Statistical divisions are working for the planning of the survey and for the processing of material NSS is now able to supply an integrated picture of large sectors of the national economy and of practically the whole of the consumer expenditure in India.

(d) *Data Base for Economic Development*

I shall refer to another area where Statistics playes an important role. The fundamental aim of national planning is to increase the general level of living of the people. This is possible when the total production or more precisely the production per head is increased. In fact the total increase in the level of living is more or less equal to the increase in the total production.

National income Statistics in its broadest sense is an attempt at preparing the accounts relating to national economy as a whole. National income consists of the aggregate value of all goods produced and all services rendered and thus includes the values of all agricultural produce (including forest products and fish), all articles manufactured by industrial establishments or in cottage industries, all transport and communications, the value generated by trade and commerce and also the value of professional and other services rendered to society as a whole together with the net balance of the flow of commodities and money across the boundary of the country. It is necessary, of course, to avoid the double counting. The total national product is used broadly in three different ways. The greater part is consumed other part has to be used for repairs, replacement etc. the balance after meeting current consumption and depreciation is what is called savings and is available for investment. It is only by making fresh investment that the productive capacity can be increased from year to year.

The National Income Committee which was appointed by the Government of India in 1949 estimated that the total national income of the Union of India in 1948-49 was about 8700 crores or 87 abja. This tentative figure indicates that the average income was about Rs. 250 per person per year in 1948-49. This Committee was headed by Professor P. C. Mahalanobis. Estimates for successive years can indicate in a broad and general way whether the economic condition of the nation as a whole is becoming more prosperous. In order to formulate national policy, more detailed information is needed and the Statisticians should supply information in greater detail by breaking up the aggregate national income into various sectors.

Statistical methods in commerce and industry can lead to large economics and improved production at a low cost. In this connection Statistical Quality Control and Reliability and methods of Operations Research may be mentioned.

It is the task of the Statisticians to do what they can to improve the quality and quantity of information required for national planning and development. Some of the data may be required for current use and some may have to be collected for future utilisation. The point to be stressed however is that Statistics must have some purpose practical or theoretical and for immediate and future use. Once the purpose for which Statistics is required has been made clear it becomes possible to construct suitable concepts, definitions and standards. Also as information begins to be collected and utilised it becomes possible to make necessary improvement in the method of collection and processing the data and in the utilisation of the information more and more effectively. Statistical information should be of decisive significance in making important policy decisions.

Part II : Four Decades of Planning in India (1950-1990) — An Appraisal

Planning in India began with the establishment of the Planning Commission by a resolution of the Government of India dated 15 March, 1950. Since then Planning Commission has prepared Seven Five Year Plans and two draft plans. The basic objectives have been articulated differently in different plant but in essence they boil down to four things : first rapid economic development, second modernisation and structural transformation of the economy, third the attainment of self-reliance and fourth the removal of poverty and inequality. Let us examine to what extent we have achieved our targets. With regard to the first objective it may be stated that in the First Five Plan envisaged a doubling of per capita income by 1977. In actual fact income in 1977-78 was about 25 per cent higher than 1950-51 level, therefore the short fall is substantial. This is due to wrong assumption about the rate of population growth. the First Plan assumed a population growth rate of 1.25

per cent, per annum according to this rate 1977-78 population would have been 502 million where as in fact it was around 629 million. On an overall basis the average annual growth rate over the plan periods has been around 3.8 per cent which is well below what we have aimed at and what we need to achieve. With regard to structural transformation and modernisation, we have made some progress, the share of primary sector in national production fell from 596 per cent to 44.6 per cent and the share of secondary sector rose from 14.5 per cent to 22.2 per cent. The second major area of modernisation is in agriculture. In this area our achievements are formidable. After attaining the highest yield of food grains (150 mt) in 1984-85, it has come down to some extent. It is necessary to regain the lost momentum of agricultural growth so that in 1989-90 we can achieve 175 mt of food grains. In recent years there is visible sign of growth of self-reliance. During the drought of 1965-66 we needed a substantial measure of aid and food assistance from international community to manage the situation. In 1972-73 we had to resort to imports but did not have to seek food aid. In the latest drought we managed even without resorting to food grain imports because of the level of stocks that had been built up. We have failed to achieve self-reliance in the areas of import substitution and balance of trade. The first and the fourth objectives is economic development and the removal of poverty and inequalities. We find our plans have specifically laid emphasis on accelerating the pace of economic growth. However the plans failed to realise that a rapid increase in population eats away the fruits of growth and per capita income fails to increase as much. The plan did not have a strong and purposeful population policy. Provisions for population control have been inadequate and implementation programmes are still weaker. As a result India has faced a situation of population explosion and per capita income recorded only a limited increment. India suffers from a vicious circle of poverty. Its income level is low and large percentage of people live at or below subsistance level e.g. it is estimated that 48 per cent of rural population and 41 per cent of urban population is below poverty line. Indian per capita income is one of the lowest in the world. Given a capital : output ratio of 3.1 and a need to save 5 per cent for maintaining our capital resources intact we need to save 15 to 16 per cent of our national income in order to achieve some increase in per capita income per annum. Our current savings are far below this rate. One of the major objectives of the plans has been that of reducing unemployment which is a chronic problem faced by our country. We have not only massive open unemployment but also disguised and seasonal varieties. During the 40 years of planning we have failed to achieve the projected targets of the plan objective namely technology and economic self- reliance removal of poverty, generation of gainful employment and strengthening of the agricultural and industrial base (see appendix). I am citing a few instances. The fourth plan aimed at increasing the national income at 5 5 per cent per annum, 5 per cent growth rate in agricultural production and 8 to 10 per cent in industrial production. It aimed at limiting growth of imports to 5.5 per cent per annum, and raising the export growth to 7 per cent. None of them could be realised. The sixth plan aimed at enrolment 95 per cent of the children in the age group 6-11 in the first stage and 50 per cent in the age group11-14 by the end of the plan and the universal enrolment in the age group 6-14 by 1990. The removal of poverty was the foremost objective of the Sixth Plan. We could not fulfil our commitments.

There may be reasons for this failure but the principal one according to me is that from the Third Plan onwards no statistical assessment has been done rigidly as a result of which no effective steps were taken to rectify the defects inherent in the formulation of the plan.

As the production of a given quantity of one commodity will require appropriate quantities of other materials, the production targets will be all inter-locked through inter-industry relations. It is necessary therefore that production targets should be internally consistent in the sense that requirements at each stage will be balanced by supply. If there is any lack of balance then there will be shortages and bottlenecks which will create delays and hamper the process of production or even can bring it to a stand still. Similar balances will have to worked out for requirements of man power. The investments required to achieve the targets of production will have to be worked out and balanced with financial resources. To formulate such a plan of production will obviously require a large amount of detailed information of many kinds such as inter-industry relations, capital required for each unit of production, increment of income and of employment per unit of additional investment, pattern of consumption of different goods and services and how this pattern changes with increase of income, requirements of transport and many other things. These basic Statistical informations are not always available. In spite of this we try to fix targets in the productivity sector.

The responsibility of the Statisticians does not end with the preparation of plan. Suitable methods must be devised to assess the progress of the plan in physical terms to ascertain to what extent production targets are being realised, unemployment is decreasing, levels of income and consumption are rising and social and cultural benefits are accruing. The need of a wide variety of detailed information for purposes of planning is keenly felt. Our greatest difficulty has been the acute shortage of Statistical staff at different technical levels. Though the trained Statistical personnel is available in the country still the Covernment does not make use of them properly. To assess the progress of the plan annually determined efforts are necessary but uptil now they are not vesible.

Even though we have a vast infrastructure for collecting Statistical information still Data System for plan formulation is inadequate. If should all quantitative information with regards to

(a) natural resources such as land, water, forests, minerals etc.

(b) human resources in all their samifications, and

(c) a whole lot of techno-economic information parameterised in the shape of technical coefficients and the like.

The interaction between the Scientist and Statisticians in the field of natural resources data has so far been minimal. We are far from having adequate inventories of our natural resources and it is high time for Statisticians to come up with Statistical techniques which can cut short the time and effort required for building complete resouce inventories. Statisticians should pay urgent attention to the application of sampling techniques in the field of soil, land capability, forest wealth, underground water and mineral surveys. We have fairly reliable Statistics on population dynamics but concepts and coverage have seriously jeopardized the comparableness of data over time. In consequence a fair proportion of these data has become unusable for planning and projection purposes. Standardisation of concepts and definitions is of paramount importance. Data System for current economic intelligence is available but it suffers from following defects :

(i) lack of timeliness

(ii) lack of consistency

(iii) non-availability of the possible estimates of error.

Quality of base line data should be improved for which following suggestions are given

(a) Computation of Statistics must not be left to clerical staff of indifferent quality

(b) Producess and users of data must have close communications between themselves.

(c) Research workers in Universities and Institutes must take keen interest in finding out how the basic data are collected and compiled.

The next part of information system relates to monitoring of plan and project implementation.

Activity of monitoring should be decentralised and it is necessary to have an overall design for the system on a technically sound and uniform basis. Monitoring of the information system is still a new activity where the services of the Statisticians are called for. Regarding the existing data base for planning purposes in India, I conclude my review by quoting a statement made by Sri Sam Pitroda, advisor to Prime Minister on technology missions —

> "After taking charge of technology missions, I have started reviewing the Statistical data and other basic information required for setting a practical target. I have asked for information about villages where there is not a single source of drinking water. They gave me a figure regarding places where there are no potable water sources. But when I asked for the names of these villages they simply drew a blank. The people in governmental administration love Statistical jargon first to show that they are smarter than you without probing into correctness of data. Incidentally the other day we met West Bengal finance minister and a few secretaries of the department at Writers' Buildings. At the meeting some one asked one of my officers a probing question on the immunisation programme. We really did not have the answer. But my officer tries to out smart the questioner by statistical jugglery. This is wrong. One must have the gets to admit that he does not know." This is how we are planning.

In the sphere of development planning and overall economic formulation the role of Statisticians and Statistical offices need to be reoriented in the light of the experience of the past and the requirements of the future. The importance of Statistics in formulating development plans had been recognised from the time India achieved independence when in January 1949, Professor P. C. Mahalanobis was appointed as Honorary Statistical Adviser to the cabinet and a few years later concurrently worked as a member of the Planning Commission. In 1954 the Planning and State Statistics Division of CSO started functioning as Statistics and survey division of the Planning Commission to provide the desired Statistical support in the actual planning process. The dominant role of Statistician does not exist after Nehru and Mahalanobis. Although Statistics has come to be recognised as a necessary adjunct at various stages of planning, the role of Statistician generally ends up with providing the necessary data for planning and he has little say in the decision making. Though Statisticians are competent and able persons to take part actively at decision making process, they are practically debarred. The responsibility for decision making in regard to Statistical Operations lies within the purview of the activities of the Statistical offices subject to overall administrative approval by the administering ministry. These decisions pertain to method and procedures for collection, processing, analysis and dissemination of data improvements in quality, timely availability, concepts definations and classifications to be used, the degree of error to be allowed and identification of gaps etc. Even on technical matters Statisticians are not allowed to decide, they have to obtain final sanction from the administrators who are completely ignorant about the subject.

The problem of planning in India is that it should have a time horizon say 15 to 20 years. The basic principle is that the right quantity of goods must be made available at the right moment, either for consumption or for investment and the right number of technical personnel must also be made available to produce and utilise the same at the right moment. For this work the role of Statistics is indispensable. Planning should touch the life of each and every citizen and the commonest among the common men should understand the goal and meaning of planning. There must be a participation by the masses in the process of development and the state should have a minimum role to play in such a process. This is not happening in India therefore it is felt that there is an urgent need for policy changes in the working of the Planning Commission. ☐

APPENDIX

TABLE 1 : Indicators of change with time

Indicator	Unit	1950-51	1977-78	1984-85	2000 (Expected)
1. Population	Million	358	623	761	986
2. Birth Rate	Per thousand	39.9	34.5	32.6	23.1
3. Life Expectancy	Years	32.0	53.2(1974)	56.5	64.0
4. Literacy Rate	% population	16.7	29.5	37.0 (Male 47% Female 25%)	100.0 (1990)
5. GDP at Factor Cost	Rs. Million	95,030 (GNP)	800,000 (GNP)	19,34,280	40,21,430
6. Food Grain Production	Million tonnes	50.8	132	150	235
7. Industrial Production	1970-100	27.0	148	182.3	-
8. Electricity	Million KWH	5107	98500	167000	575000
9. Towns & Villages Electrified	Numbers	23,980	2,07,346	3,68,840	4,86,941 (1990)
10. S & T Persons	Per thousand	188	2328	2853	4000
11. Universities	Numbers	27	105	145	-
12. S & T Expenditure	Rs. Million (at current prices)	47	5587 (1978-79)	18906	-
13. Communications :					
(a) Telephones	In lakhs	1.68	22.47	34.62	-
(b) Telex Exchanges	Numbers	-	101	176	-
(c) Telex Subscriber	Numbers	-	14641	22552	-
14. Exports	Rupees Crores	600.64	4036.26	11465.95	-
15. Per capita income	(at 70-71 prices)	558.8	663.5	748.6	-
16. Scientific Journals	Numbers	-	708	2000	-
17. Patients	Numbers	-	3065	3008	-

Sources : (1) The Seventh Five Year Plan 1985-90, Govt. of India; (2) Science and Technology in India by A. Rahman, CSIR, 1985; (3) Research and Development Statistics 1984-85, DST; (4) India 1985 Reference Annual, Govt. of India.

TABLE 2 : Growth rates of foodgrains production⁺ and population⁺⁺

States	Food Production (1960-61 to 1978-79)	Population (1961-79)
1. AndhraPradesh	1.69	1.68
2. Assam	2.36	3.00
3. Bihar	1.92	1.69
4. Gujarat	3.56	2.34
5. Haryana	5.33	2.34
6. Karnataka	3.40	1.91
7. Kerala	1.39	2.19
8. Madhya Pradesh	1.67	2.36
9. Maharashtra	1.77	2.19
10.Orissa	1.19	2.19
11.Punjab	8.01	1.69
12.Rajasthan	2.97	2.37
13.Tamil Nadu	1.83	1.52
14.Uttar Pradesh	2.79	1.68
15.West Bengal	2.72	2.34
All India	2.77	2.01

+ Source : Alagh, Y.K. and P.S.Sharma, 1980.
++Registrar General of India

TABLE 3 : States classified according to growth rates in region to national average

		Food	
		Greater than National Average	Less than National Average
Population	Greater than National Average	Haryana, Gujarat, Rajasthan	West Bengal, Assam, Madhya Pradesh, Orissa Maharashtra Kerala
	Less than National Average	Punjab, Karnataka Uttar Pradesh	Bihar, Tamil Nadu, Andhra Pradesh

Observations of Prof. Bhabatosh Dutta, Chairman at the conclusion of Prof. P. K. Bose's Lecture

I am sure you will all agree with me that we have just heard a very learned and stimulating lecture from Professor P. K. Bose. I remember that Professor Mahalanobis tried to give a detailed answer to the question "Why Statistics"? in 1950 when the stage was being prepared for the initiation of development planning in India. He wrote again and again on the same question and, as you all know, was the author of the famous Mahalanobis Model which has been the basic frame work of our plans since 1956. It is only proper that one of the most distinguished disciples of Professor Mahalanobis should report to the same question now and examine all the developments in the light of four decades of experience.

The first part of Professor Bose's lecture shows clearly how statistics can help and has helped Indian Planning—not only through the collection and processing of data but also through the introduction of specialised techniques. These involve the designs of experiments for higher productivity—especially in agriculture, sample surveys and improvement of the data base. These all are matters of technical expertise and I cannot go beyond what Professor Bose has said.

When, however, he comes to the second part of his lecture—seeking to appraise four decades of planning in India, the economist has something to say. There are these days large numbers of econometricians who combine statistical and economic analyses, but even those who are not experts in this specialised field realise that there have been deficiencies in our efforts. Broadly, we had expected that our gross domestic product (GDP) would grow at the rate of 5 per cent per year or more, but the actual growth rate upto the sixth plan was in average only 3.6 per cent. The current seventh plan appeared to be likely to achieve its growth target, but the drought of 1987 severally affected the time-path of our outputs.

Many questions arise. The first of these relates to the definitions used. We can define the gross domestic product (GDP), the net domestic product (NDP), the gross national product (GNP) and the net national product (NNP). Each of these we can measure at "factor prices" or at "market prices" (i.e. factor prices ± indirect taxes or subsidies). Each of these can again be measured at current prices or at constant prices. (The base year has now been changed from 1970-71 to 1980-81). There are two difficulties involved in this. Unless we are careful to stick to one particular definition throughout a particular analysis, we may produce conflicting conclusions. There is also the problem of "netting" and there has to be a standard procedure for all this.

The second difficulty of a research worker is that there is not only a long delay in the publication of the data, but often the figures once published are subsequently revised substantially. The food grain output for 1986-87 was, for example, given as 150.57 million tonnes and then was revised one year later to 144.07 million tonnes. As food grains constitute a large part of our total output, this revision required a downward adjustment of our GDP figures also.

Apart from material production, there are the "services" which constitute a large part (35 to 40 per cent) of the GDP. Some of the services can be quantified—e.g. banking, insurance, transport etc. But there are many others. How do we evaluate the contribution to the GDP of the large number of government employees, of the military forces, of persons performing personal services (like washerman or street sweepers)—or, if you do not mind, of university teachers? We can take or estimate their incomes, but that often means begging the question. In socialist countries, the only measures provided are those of the national *material* production. I don't think we should exclude the services, but our methods of estimation have to be improved.

All this reduces the value of general statements about growth rates. The government can show an increased GDP simply by enlarging the army. Besides, the GDP estimates make no distinction between luxury goods and mass-consumption goods. A Rs. 1000 crore increase in the output of cosmetics has the same effect on the GDP as a Rs. 1000 crore increase in the food grains output.

And then these is the question of income and wealth distribution. We had stated with the idea of attaining "growth with justice", but even after 37 years of planning and with our high quality statisticians, we do not yet know what is the decile-wise distribution of incomes and assets in 1987-88. Some conclusions are drawn from an unjustifiable blowing up of the results of some exercises undertaken about 12 years ago, but apart from their inadequacy, the position now may have changed substantially. All that we have is a "poverty-line", defined in terms of calorie requirements and a few other essentials, and placed now at Rs. 6400 per household per year. The percentage of people below the line is reported to be 37 or there abouts. The households below the poverty line were divided into four sub-strata, but we do not know anything about the movements from one stratum to another. All we get are the figures for households assisted under the poverty alleviation programmes, but there is no detail about the number of eligible households in each group.

Our trade and monetary data have improved considerably, but we cannot establish the necessary links between commodity flows and financial flows. The Mahalanobis model suffered from the defect of assuming that whatever was physically feasible would also be financially feasible. Our experience has shown that this is not true and we know particularly how inflation distorts all estimates and also creates an under current flow of black money. We have financial flow statistics in broad terms—i.e. among households, banks, corporate sector, government etc., but we require more detailed matrices—so that we may superimpose a financial flow matrix on our input-output matrix or commodity balance matrix.

The subject is complex and extensive. We have achieved much in every field. We have also had big failures in reaching our major objectives. In seeking to reach all the objectives together, we require political will on the one hand and expert knowledge on the other. Statisticians have a big role to play in improving our information base and the linkages in the economy. Professor Bose has made an expert evaluation of the achievements and failures of the last four decades and we can all hope that our next four decades will be managed much more efficiently that the last four. On behalf of you all, I thank Professor Bose for his very illuminating address, which he concludes by emphasising the urgent need for policy changes. □

SCIENCE AND TECHNOLOGY IN NINETEENTH CENTURY GERMANY*

S. N. SEN**

In the exhihition on Science and Technology in 19th century Germany organised at the Birla Industrial and Technological Museum in collaboration with Max Muller Bhavan, the choice of the century for the development of science and technology as well as the country which contributed to that development has indeed been very appropriate. For, although modern science had its origin during the sixteenth and seventeenth century its maturity took place in the neneteenth and it was again in the nineteenth century that the foundation for the great scientific revolution of the twentieth century was laid. In this effort Germany played a predominant part particularly in the latter half of the nineteenth century.

Compared to older centres of science and technology in England and France, Germany was a late comer due to a variety of reasons. The historians would have us believe that this was due largely to the effects of Reformation which diverted the attention of her intellectuals to religious questions. For thirty years, from 1618 to 1648, the country was engulfed in the holocaust of civil and religious strife and potically dismembered into a confederation of petty despotism. No wonder that in such a situation the country sank into the bottom of intellectual and scientific activities. Yet from the fifteenth century, German technicians and craftsmen had enjoyed a measure of reputation as good as anywhere in Europe. Even during the period of her intellectual decline, she produced Johannes Kepler (1571-1630), one of the leading architects of revolution in astronomy, Otto Von Guerecke (1602-1686), Burgomaster of Magde burg, who was associated with the pneumatic revolution and Gottfried Wilhelm Leibnitz (1646-1716) who invented calculus independent of Newton and founded the Berlin Academy.

By the beginning of the nineteenth century England and France had marched ahead in scientific and technological pursuits not so much by the intrinsic qualities of their scientists as by the forces of their mercantile, political and colonial advantages. In the eighteenth century, English lead following the Newtonian revolution in mechanics and astronomy had passed on to the French. More importantly France made a great leap forward through the chemical revolution of Lavoisier and England ushered in the industrial revolution by harnessing the power of steem. When we look at the Napoleonic reforms and reorganization of science, the emergence of institutions like École Polytechnique, École Normal Superieur, Conservatoir des Arts et Metier and several others and the galaxy of French scientists like Lagrange, Laplace, Fresnel, Aroge, Biot, Carnot and Fourier we have no difficulty in realizing why France at the beginning of the nineteenth century was universally acclaimed to be in the vanguard of science and technology.

By 1848 the scales were turned in favour of Germany. The international trade fairs and exhibitions organized in Paris, London and Chicago in the years 1851, 1855, 1862, 1867 and 1876 clearly demonstrated the progressive rise of Germany as an industrial power. The products of her industries, in quality and quantity, posed an unquestionable challenge to those of France and England. After the World Fair in Chicago, one of the English Commissioners observed that Germany had doubled her exports and lifted herself to a point of vantage equal to that at which England started in 1846. In many manufacturing fields she had surpassed England.

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*Based on the inaugural address delivered at the Birla Industrial and Technological Museum on April 6, 1988.

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The change was brought about by a member of factors, both political and non-political. The most important political factor was the unification of Germany, which ended the medieval dismemberment of the country into 26 weak states. This unification released new energies and paved the way for reform and reorganization in the field of education and higher learning. The second factor was a deep realization of her comparative backwardness in science and technology and an intense nationalistic desire to reverse the situation. After the defeat in 1806 of the Prussian army at the hands of the French, German patriots like Fichte and Stein made no secret of the fact that German military reverses were due to superior French science and industry and to institutions and organizations founded by Napoleon. From the beginning, therefore, German unification aimed at strengthening the base of science and technology. Here certain imitation of French models was inevitable but Germany preferred not to do it blindly. Instead of following Napoleonic plant of centralization of science in and arround the capital city, Germany chose to make the most of her existing institutions, namely the universities, which were pressed into service in the difficult task of reorganizing science and technology.

In this formative period Germany had to face another difficulty, namely the opposition of Nature Philosophers (Naturphilosophie) and the followers of Hegel and Schelling, who regarded scientists as narrow specialists. The Nature Philosophers and Hegel and Schelling had considerable following in academic and intellectual circles. Fortunately, unlike the older universities of Oxford, Cambridge and Paris, dominated by obscurantist ecclesiastical groups, German universities had from the beginning a liberal tradition which quickly responded to the need for organizing science for national regeneration. One of the first universities to respond to the new urge was Göttingen, established in 1736, which soon produced a fine crop of young mathematicians like Friedrich Gauss, Wilhelm Weber and Franz Neumann and established an advanced school of mathematical physics for others to follow. In Berlin, a young group led by Poggendorf, Riess, Dove and H. G. Magnus formed an empirical or experimental school of physicists to counter the metaphysical speculations of Nature Philosophers. The activities of this group led to the concept of modern scientific laboratories in university institutions. Poggendorf started the famous periodical publication *Annalen*. Magnus pupils included Krönig, Claussius and Helmholtz.

In chemistry, teaching laboratories were initiated by Strohmeyer in Göttingen and by Gmelin at Heidelberg early in the century. But the most important step for organized chemical researches was taken in 1825 by Justus von Liebig, Professor of Chemistry at Giessen. Liebig was an excellent teacher and taught his pupils through laboratory practices. He improved methods of organic analysis and one of his early interests was the quantitative estimation of urea found in the blood of mummals. Liebig's work on urea stimulated the researches of Friedrich Wöhler (1800-82) who succeeded in 1828 in synthesizing urea from ammonium cyanate, an epoch-making discovery, proving that organic substances require no vital force but obey the same laws of chemistry as do inorganic substances Liebig's laboratory at Giessen soon inspired the establishment of similar chemical laboratories in German Universities,—at Marburg in 1840, at Leipzig in 1843, in Berlin and Bonn in 1860 and so on.

Apart from the establishment of scientific laboratories in universities, the new scientific movement in Germany introduced other innovations. Early in the movement, Franz Oken, a friend of Goethe founded the Deutscher Naturforscher Versammlung (DNV) (German Science Association) for the propagation of the message of the new experimental science. The DNV, in time, stimulated the formation of the Baritish Association for the Advancement of Science in England. The idea of publishing specialized journals was born with Poggendorf's *Annalen*. Soon it was followed by the appearance of *Zeitschrifts* in Physics, Chemistry and other branches of science and encyclopaedic serials called *Handbücher* on recent developments in particular areas of science and technology. Simultaneously the universities introduced the concept of research scholar and rewarding his work by the award of the degree of Doctorate of Philosophy on the basis of a dissertation. The Ph.D. degree soon became highly popular throughout Germany and gradually in other countries.

There was yet another innovation of profound significance to industrial development, namely, the establishment of a close liaison between the university and industry. By this concept the universities and technische hockschulen undertook to train research workers in large numbers in newly emerging technologies so that qualified workers could be readily available in requisite strength when a new technology needed to be transformed into an industry. This happened at first in the chemical industries and later on in the electrical and other research intensive industries. This was the key to German success in capturing initiative in manufacturing enterprises such as the dye industries, steel, electrical and many other industries of the nineteenth century.

These various reforms and movements introduced during the first half of the 19th century bore fruit during the second half. To give a few examples from Physics, the new and emerging areas of research in this subject in the century were astrophysics, thermodynamics, electromagnetic waves and atomic physics, in each of which German physicists left their indelible mark. Astrophysics was born when Joseph Fraunhofer (1787-1826), in the second decade of the 19th century, discovered the dark lines, now known as Fraunhofer lines in the solar spectra. This early beginning was developed into a powerful branch of physics and chemistry, that is spectroscopy, in the hands of Gustav Kirchhoff and Wilhelm Bunsen during the fifties and sixties of the 19th century. Both of them working jointly discovered two new elements,—Ceasium and Rubidium. Kirchhoff often used to say that he was searching for gold in the sun. His banker once ridiculed him by saying what the use of his search was if he could not bring it down to the earth. When he received a gold medal from England for his discoveries, he told this story and observed, "Look here, I have succeeded at last in fetching some gold from the sun".

Thermodynamics stemmed from the 18th century discovery of steam engine and became a lively subject of research all over Western Europe. Two of its fundamental concepts were the conservation of energy and entropy. Robert Meyer and Hermann Helmholtz were among the early pioneers who hit upon the idean of conservation of energy, embodied in the first law of thermodynamics. The concept of entropy was due to Rudolf Clausius.

Between 1819 and 1835, the foundation of electromagnetic researches were laid by Hans Christian Oersted (1771-1851), Andre Marie Ampere and Michael Faraday. Out of the various threads of their work James Clark Maxwell, in the seventies of the century, developed his famous electromagnetic theory of light. The practical generation of electromagnetic waves and demonstration of their optical properties were left to young Heinrich Rudolf Hertz (1857-1894) who, in 1885, at the age of 28 performed his famous electromagnetic experiments. He produced these waves from oscillatory discharge of a Leyden jar, observed magnetic and electric waves separately and proved that these could be diffracted and polarized like light waves. In time Hertzian waves opened up the new branch of radiophysics with immense possibilities to be realized in the present century. In electromagnetic work Hertz was not the lone flame in Germany. He was preceeded by a number of other distinguished contributors of whom special mention should be made of Carl Friedrich Gauss, Alexander von Humboldt, Wilhelm Weber and Emil Lenz.

Atomic physics had its origin in the so-called discharge tube phenomena. Early pioneers in this field were Heinrich Geisslar, a glass blower of Tübingen and W. Hittorf. Geissler delighted in making vacuum tubes for producing electrical discharges with beautiful colour effects. In 1868 Hittorf experimented with the dark space phenomena spreading from the cathode and the fluorescent glow from the glass walls. These experiments followed up by Crookes and others led to the discovery of electron and x-rays. The discovery of x-rays by Rontgen in 1895 was a turning point in modern physics.

This brief survey shows that in physics, by the end of the 19th century, Germany had definitely caught up with France and England, but probably did not have an overwhelming lead. This was, however, otherwise in chemistry. Prof. D. S. L. Cardwell, of the University of Leeds has shown that in 1866 chemical laboratories in Germany produced six times as many research papers as in Britain. In 1899, two thirds of the world's original chemical researches came from Germany alone. Its effect on German chemical industries was unmistakable. By 1870 German chemical industry was at a higher level than that of England and France. *H. Kolbe,* in his *Das chemische Laboratorium der Universitat Leipzig* (1872) explained this by the superior, thorough and intensive chemical education organized in Germany. We all know that aniline dyes were discovered in England in 1858 by W. H. Perkin. Perkin had his training in organic chemistry from German organic chemist A. W. Hofmann, a pupil of Leibig. Perkins, father and son, started a dye manufacturing company which prospered till 1874 and then closed down. By then large synthetic dyestuff industries spearheaded by several hundreds of research chemists trained in universities and technical high schools, had appeared in Germany to command the international market. We can easily imagine the economic benefits accruing from the dyestuff industry when we remember that the production of cotton cloth increased from a mere 40 million yards in 1785 to 6,500 million yards in 1887. Similar results were achieved in almost all industries typical of the nineteenth century,—in the steel industry, in the electrical industries and others. □

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Notes and news

Embryo transfer helps inferior cow deliver exotic calves

A genetically inferior cow gave birth to a cent per cent high-yielding variety—exotic "Holstein-Fresian" female calf—through frozen embryo transfer on May 3 at the Raymond's Embryo Research Centre at Gopalnagar in Madhya Pradesh's Bilaspur district. This high-yielding breed is found in Holland and Germany.

The centre's veterinarian, Dr. Shyam Zawar, said here yesterday that it was a breakthrough in the embryo transfer cattle breeding technique. He said pregnancies have been successfully established in eight other cows through the same technique.

The centre has also to its credit, as the pioneer in the technique, the successful delivery of cent per cent high-yielding exotic Holstein-Fresian embryo transfer cow to a purely indigenous variety cow under village conditions.

As many as 31 cows gave brith to 34 calves, including three twins, by way of embryo transfer at the centre last year. Another 40 pregnant embryo recipient cows will give birth to embryo transfer calves within six months, Dr. Zawar said.

The embryo transfer breeding technique is an ideal solution to increase the population of high-yielding variety of cows. Against the normal delivery of one calf by natural breeding, a donor cow can donate 36 to 48 embryos which when transferred to local cows can result in 18-24 superior calves in a year, he said.

The foster mother cow works as an incubator for the young one and does not impart any of the genetic characteristics of her own to the offspring.

In embryo transfer, fertilisation of the ovum (egg) with the sperm is effected inside the cow's uterus to obtain more than one fertilised ovum, while in test tubg baby, the same is achieved outside the human body in a petridish and then implanted in the human uterus to overcome infertility problems. ☐

The Hindu
9.5.88

Manned Craft to Explore Deep Sea

The USSR Academy of Sciences intends to invite foreign scientists to participate in investigating ocean depths with a new deep-water craft, "Mir-1" which has been developed jointly by Soviet and Finnish experts. The deep-sea manned craft has no parallel in the world.

Researchers had been charged with the task of developing a deep-water self-sustained craft, capable of ensuring geological, physical, biological and chemical investigations in ocean. While the USSR Academy of Sciences shouldered all the scientific part from design assignment to guidance of tests, the manufacture of the craft proper as well as of lowering and lifting systems were made by the Finnish firm "Rauma-Repola."

Last December, the research ship *Akademik Mstislav Keldysh* took aboard the craft "Mir-1" and "Mir-2" and headed for the Atlantic where tests were held. For the first time in the world practice design parametres were reached and in some cases surpassed during the first tests. The "Mir-1" dived to 6,170 metres deep and the "Mir-2" to 6,120 metres. Systems of ultrasonic communications with the ship, television and wide-format stereo photocameras worked well. Two manipulators having seven degrees of manoeuverability (an operator can flex and turn them in the most surprising way) lifted underwater 80 kg loads.

Power packs of the craft are designed for underwater travels with a speed of five knots. According to specifications, oxygen reserves are enough for a crew of three to stay underwater for three days. Professor Igor Mikhaltsev, head of the experiment, Anatoli Sagalevich, D. Sc. (technology), and Pekko Laakso, a representative of the Finnish firm, were on the crew during all the first six dives.

"We have got a unique opportunity for ocean investigations," said Professor Mikhaltsev, "and are ready for cooperation with scientists of any country for peaceful purposes." In February the "Mir-1" and "Mir-2" will head for their first working geological voyage. ☐

APN

Aspartame causes mental illness

Aspartame is a dipeptide of aspartic acid and the methyl ester of phenylalanine. First synthesised in Japan, it now occupies a large part of the UK, US, Canada and France markets. Aspartame is a low calorie sweetener and tastes 200 times sweeter than table sugar. In the US, the sweetener is marketed by the name Nutrasweet. Several million people in the US consume products containing the sweetener.

Researchers for Medical Research in Florida reported that aspartame in high doses causes mental illness. Although aspartame itself is not toxic, it affects mechanisms controlling carbohydrate and protein intake and helps to increase phenylalanine levels dangerously in individuals. Despite the fact that other foods may also raise phenylalanine levels, aspartame has the difference that it cannot limit brain levels of phenylalanine whereas foods contain other amino acids and can limit its level in the brain.

Aspartame breaks down into phenylalanine (50 per cent), aspartic acid (40 per cent) and methyl alcohol (10 per cent). It is now reported that it is methyl alcohol which damages retina. Phenylalanine, on the other hand affects the brain and the nervous system.

People who drank two litres of soft drink containing aspartame a day failed memory and went into convulsions. The said thing happens if any one goes on using chewing gum containing aspartame—the artificial sweetener for a prolonged time. But it has been found that both memory loss and confusion can be reversed if consumption of the sweetener is allowed to stop. These experiments also indicate that aspartame in heavy doses is not at all good for health. □

P. C. Bhattacharyya

Madhya Pradesh is being launched as the centre of Atomic Research in 21st Century

Indore, in Madhya Pradesh is humming with activity with the transfer of about 250 scientists from the Bhabha Atomic Research Centre (BARC), Bombay. On the 1800 acres of land given by the Government of Madhya Pradesh, absolutely free of cost, the sprawling Centre for Advanced Technology (CAT) is rapidly taking shape. This commercial centre of Madhya Pradesh will soon be known for high technology for the coming century.

CAT was envisaged, in the first instant, to give the future accelerators of the country; to develop the know-how and then install the turnkey projects at various places in the country. With the shifting of Laser Division from BARC Bombay to Indore, new impetus to R & D will be obtained. Concepts like acceleration of charged particles with lasers are emerging and CAT will embark on such futuristic tasks with no time lag and could be as well be leading in them.

In a recent seminar held at Indore sometimes ago, on collaboration between CAT and the universities and industries in Madhya Pradesh, Dr. P.K. Iyengar, Director, BARC, Bombay said that CAT will develop programme on accelerators, lasers and fusion related technologies and grow into a thriving academic centre where scientists and technologists from various countries could experiment with new ideas. Dr. Iyengar aspired that India would be on the vanguard of research not only in the fundamental nuclear sciences but also in energy generation in the 21st century.

Recently Dr. Iyengar signed an agreement with the Government of Madhya Pradesh for setting up a tin smelting foundry in Bastar. Also a nuclear power plant will be set up in Madhya Pradesh and a site near Gwalior has been suggested. This region has neither water to go in for hydal project nor coal for thermal power station. Hence the region is ideal for nuclear power plant. After the final decision it might take four-five years to install the power plant according to Dr. Iyengar. □

B. B. B.

Letters to the editor

Effect of gibbrellic acid on the level of nitrate reductase activity during germination and early seedling development of mungbean (*Vigna radiata* L. Wilczek)

Much work has been reported on the effect of GA_3 on development of enzyme activities during the germination of cereal grains[1-6] but its effect on nitrate reductase (NR) activity in germinating seeds of leguminous plants has not been investigated so intensively. The present study examines the effect of GA_3 on NR activity during germination and early seedling development of mungbean.

Seeds of mungbean, cv. S-8 were sterilized with 0.2% murcuric chloride and then washed thoroughly with distilled water. These seeds were soaked in 10, 50 and 100 ppm. GA_3 solution for 4 hrs and then planted on moist filter paper placed in large petriplates. Appropriate controls were run in distilled water only. Seedlings were raised at a temperature of 25 ± 2°C in the light intensity of 5 Klux for 120 hrs.

In vivo activity of NR in the seedlings was assayed at 48, 72, 96 and 120 hrs after soaking according to the method described by Klepper *et al.*[7] and Hageman and Huklesby[8] with some modification[9]. Nitrate content was also determined in the oven dried seedlings. Nitrate was extracted following the method described by Grover *et al.*[10] Aliquot containing nitrate was then reduced to nitrite with hydrazin sulphate[11]. Nitrite was estimated by the method of Snell and Snell[12]. Seedling length was measured after 120 hrs of soaking and dried overnight at about 80°C for dry weights.

In vivo levels of NR activity was detected in control and GA_3 treated seeds (Fig. 1). Initially enzyme activity was much higher in control as compared to treatments but gradually declined when germination advanced. The nitrate content of the seeds also followed a somewhat similar pattern (Fig. 2) showing its requirement for the induction of enzyme activity. In the present study the enzyme activity was sharply reduced after initial higher level for the shortage of seed nitrate reserves limiting its role in germination and seedling growth. It appears that the early seedling growth is mainly supported by the amino acids released from the hydrolysis of the endosperm proteins[13, 14].

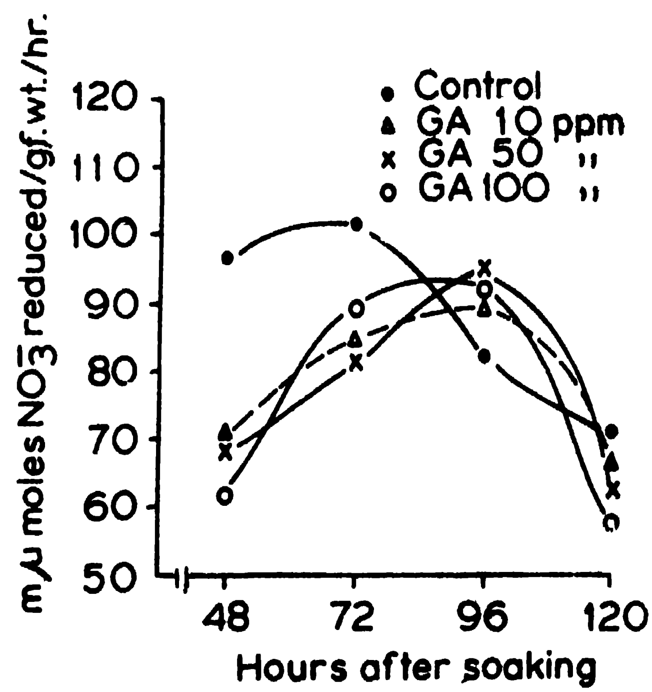

Fig. 1 : Effect of GA_3 on nitrate reductase activity in mungbean seedlings

Soaking of seeds with GA_3 caused marked reduction in enzyme activity at initial stages but as the germination proceeded further the effect was narrowed down (Fig. 1). In constrast to this the effect of GA_3 on seedling growth was found stimulating (Table 1). Nitrate level was however, not affected by GA_3 application and followed the same trend as observed in control (Fig. 2). These results suggest the possibility of two different factors working indepen-

TABLE 1 : Effect of GA_3 on seedling elongation and dry matter production in mungbean at 120 hr after soaking (Average of 10 seedlings)

Treatments	Seedling length (cm)	Seedling dry weight (g)
Control	9.0 ± .0416	0.172 ± .0006
GA_3 10 ppm	11.10 ± 0.211	0.252 ± .0122
GA_3 50 ppm	11.55 ± 0.479	0.210 ± .0151
GA_3 100 ppm	11.70 ± 0.213	0.214 ± .0147

SEM ±

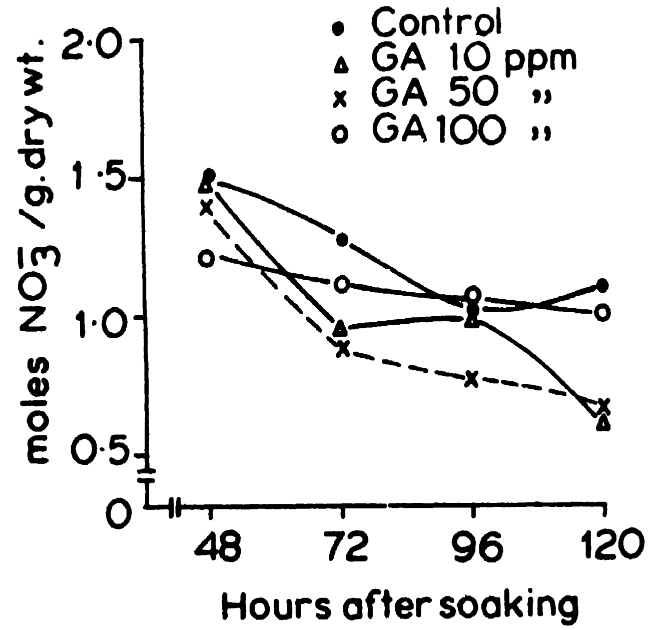

Fig. 2 : Effect of GA_3 on nitrate content in mungbean seedlings

dently in controlling the enzyme activity in GA_3 soaked seeds. Low enzyme activity at 48 hrs seems to be the result of the interference of GA_3 in the synthesis of NR whereas later revival in activity may be due to the disappearance of GA_3 from the active site of the enzyme or its utilization in other metabolic processes. It has been reported that GA_3 does not directly prevent nitrate induction of NR but it does interfere with its synthesis when incubated in the presence of nitrate for period greater than 6 hrs[15]. In the present study the NR activity measurements were started at 48 hrs after soaking with GA_3 and the enzyme activity was not completely abolished but showed marked reduction. It has been suggested that the time course of this interference may be a secondary one and the reduction in enzyme activity might be due to consequences of the appearence of GA induced proteases[15].

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Occurrence of follicular cyst in the pituitary gland of *Funambulus pennanti* (Wroughton)

Occurrence of neoplastic tissues like cyst, lymphoid tissues, ciliated and mucoid cells, tubular glands, etc. among endocrine glands is a rare phenomenon. In the human pituitary gland, ciliated and non-ciliated cysts have been reported by many investigator.[1, 2] Cysts have also been reported in the pituitary gland of wall lizard *Hemidactylus flaviviridis*.[3] In this communication the structure of the Rathke's cysts occurring in the pars distalis of the Indian palm squirrel *Funambulus pennanti* is described.

Over 150 female specimens were sacrificed for this study. The brains with intact pituitary used in this study were fixed in Bouin's fluid. 5 µm thick paraffin sections were stained in periodic acid Schiff's (PAS), lead haematoxylin (PbH) and AB-PAS-OG. (Alcian blue–periodic acid Schiff–orange G.) techniques.

The pituitary complex of *F. pennanti* exhibits typical morphological features, characteristic of the group sciuridae. While examining the serial sections of the brain with the pituitary, follicular cysts of variable shapes and sizes were encountered only in six female specimens (Fig.1).

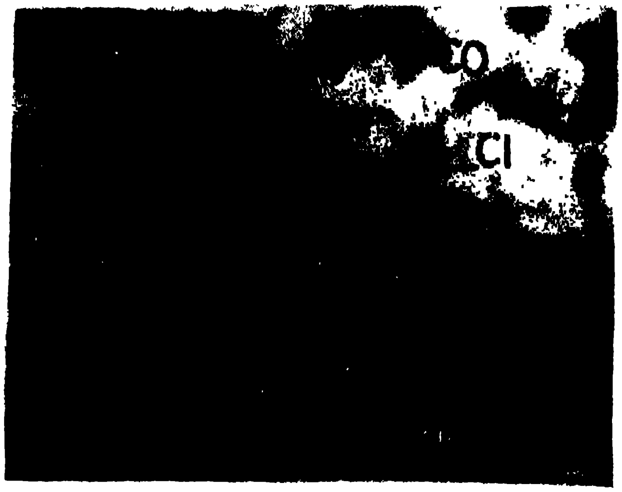

Fig. 1. Section of pituitary showing cyst (CY) in pars distalis (PD) with distinct epithelial wall (EL) PAS-positive colloid (CO) is present in the lumen. Note the continuation of colloid with the epithelial cells. Cilia are also visible in the luminal side.

Although they are restricted to pars distalis, but their distribution is not specific. There is a definite boundary between cyst wall and the component cells of pars distalis. The cyst wall is not uniformly thick. In some, it is made up of only a single layer of cuboidal cells while in others it is multilayered. The cellular profile also varies from spindle or cuboidal to columnar type. The outermost boundary is made up of connective tissue elements. The cavity of the cyst is packed with PAS-positive colloid which gives positive reaction to PAS (Fig. 2). Despite the large cysts the surrounding pituitary cells appear to the normal. The epithelial cells have cilia which are very distinct at some places (Fig. 2). The apical region in some of the cells shows PAS-positive droplets which are continuous with the luminal content of the cyst.

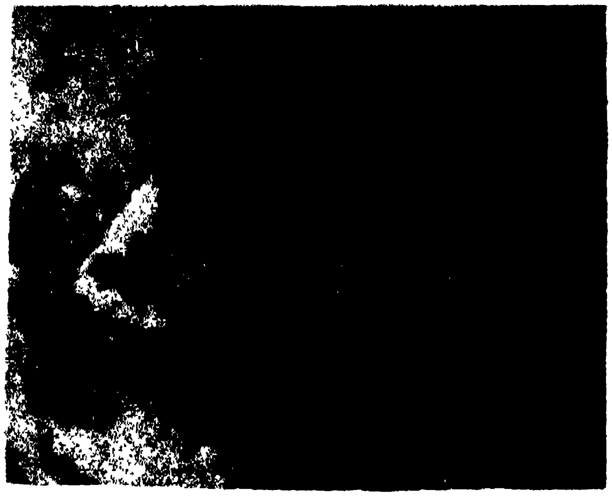

Fig. 2 Higher magnification of a part of the cyst showing bundles of cilia (CI) in the epithelial lining of the cyst wall.

Cysts from various components of the pituitary complex in mammals have been reported by Romeis,[4] Rasmussen,[2] Shanklin,[5] Vijayan *et al.*[6] Most of the cysts are classified into two major categories.[5,7] In the present study, the follicular cyst is located in the parts distalis and so it is of Rathke's type, as there is a definite boundary between the cyst wall and component cells of the pars distalis and they are situated quite deep in the endocrine parenchyma.

The identical PAS-positive reaction in the secretory material of the cyst has led Dar and Sathyanesan[8] to opine that cysts are formed in response to an increased hormonal demand. Present authors are of the opinion that follicular cells are involved in the secretion of some mucopolysaccharide containing substances and are perhaps a part of the anti-inflamatory response to some unknown causative factor.

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Changes in proton efflux and plasmalemma-bound ATPase activity during early seedling growth of mungbean (*Vigna radiata* L.)

The initial phases of seedling growth are characterized by rapid cell division and cell elongation, the latter being primarily regulated by H^+ efflux from the cytosol across the plasmalemma to the cell wall. The magnitude of proton efflux is largely dependent on the activity of membrance-bound ATPase proton pump which is activated by auxins and is operative at the expense of the energy of ATP obtainable from respiratory metabolism[1-6].

The present investigation was undertaken to study the possible correlation between H^+ efflux and the membrane-bound ATPase activity with the progress of seedling growth. It also seemed worthwhile to measure proton efflux against influx of different cations applied exogenously.

Mungbean seeds (*Vigna radiata* L. Wilczek) were allowed to germinate and grow in sterile distilled water in a dark humid atmosphere at 25°C for the desired lengths of time. Hypocotyl segments measuring 2 cm were cut from such seedlings and split longitudinally across the middle and kept in ice-cold water for 1 h and subsequently transferred to conical flasks containing 30 ml of water or other test solutions. The flasks were placed on a rotary shaker (100 rotations/min) and kept there for the requisite lengths of time and decrease in pH of the media was measured in a SICO Digital pH meter. Crude plasma membrane fractions were extracted from seedlings after removing the cotyledons according to Lindberg *et al*[7]. The pellet obtained between 12,000–25,000 g was resuspended in a small volume of the extracting buffer and assayed for ATPase. P_i released and protein contents of such extracts were measured[8, 9] in a Klett-Summerson colorimeter.

The media acidification was enhanced largely by divalent cations with an order of effectiveness as $Mg^{2+} > Ca^{2+} > Mn^{2+}$, whereas mono- and polyvalent cations tested were almost ineffective (Table 1). Al^{3+} inhibited acidification and monovalent cations like K^+ could not induce additional acidification as compared to water control. This probably indicates the existence of an electro–neutral H^+/Mg^{2+} cotransport across plasmalemma in this material. $MgCl_2$ was most

TABLE 1 : Effect of different cations (1 mM) on proton efflux from mungbean hypocotyl segments. Each value is the mean of 3 replicates (Seedling age : 72 h)

Treatment	Decrease in pH/100 segments/h
Water	0.74
NaCl	0.80
KCl	0.74
$MnCl_2$	0.97
$MgCl_2$	1.42
$CaCl_2$	1.14
$AlCl_3$	0.28

effective in promoting proton extrusion at 1 mM concentration after 1 h incubation of the segments in the medium (Figs. 1 and 2). Maximum stimulation in the rate of growth was observed between 2-3 days (Fig. 3), whereas membrane-bound ATPase activity and proton efflux reached their peak on the 2nd and 3rd days of seedling growth respectively (Fig. 4).

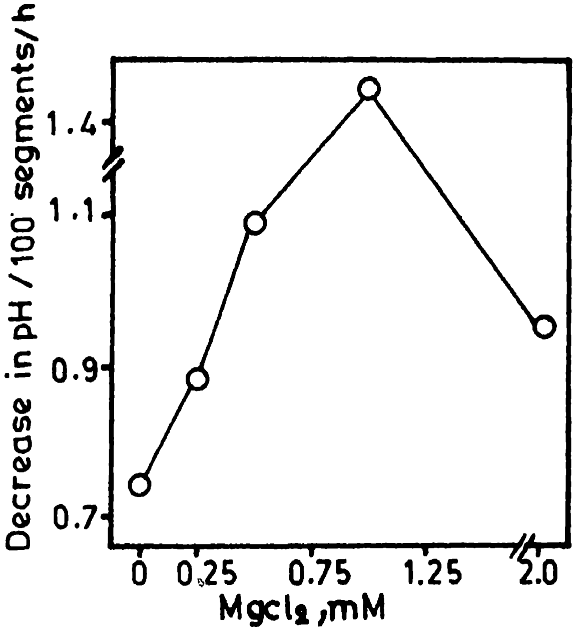

Fig.1

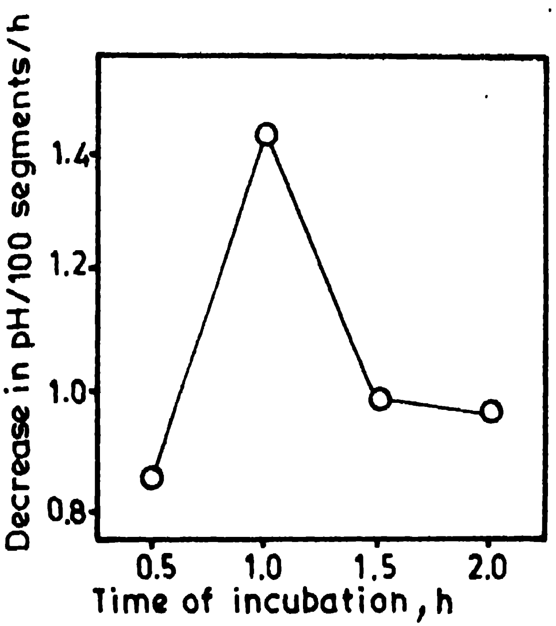

Fig.2

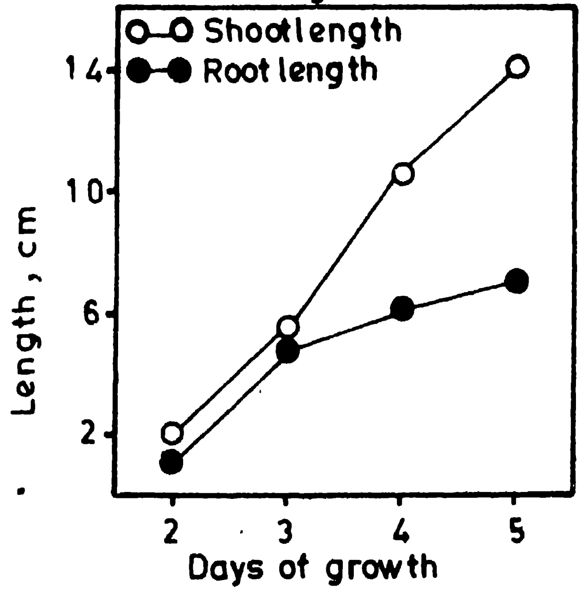

Fig.3

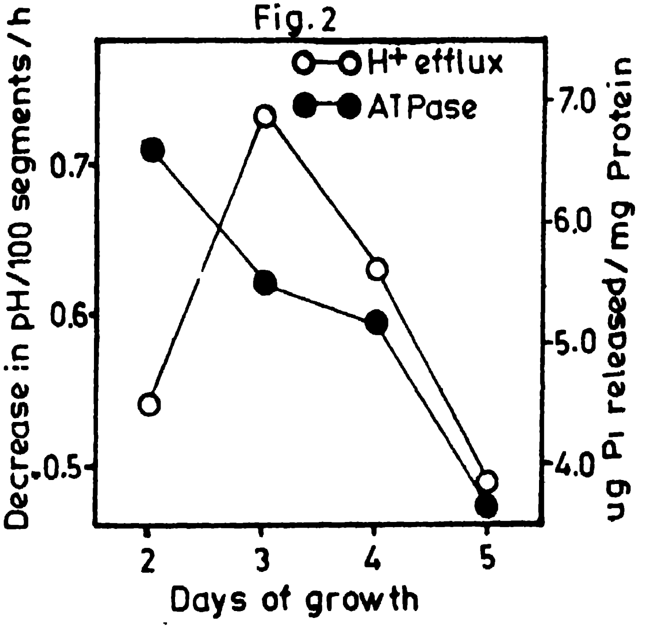

Fig.4

Fig. 1 : Effect of different concentrations of $MgCl_2$ on proton efflux from mungbean hypocotyl segments (Seedling age : 72 hr)

Fig. 2 : Effect of different hours of incubation on proton efflux from mungbean hypocotyl segments.

Fig. 3 : Increase in shoot and root lengths at different periods of seedling growth.

Fig. 4 : Changes in proton efflux and AT Pase activities at different periods of seedling growth.

During seedling growth, there is rapid utilization and regeneration of ATP involving energy-consuming and energy-releasing processes of the cell. The lag period between maximum ATPase activity and highest rate of proton efflux may be the time required for transport of H^+ ions from cytoplasm to the primary walls for inducing media acidification.

The growth rate of shoot and root was maximum between 2 to 3 days and both of them continued to elongate even when H^+ efflux and ATPase activities were reduced significantly (Figs. 3 & 4). The acidic pH activates the enzymes needed to break glucosidic bonds of extension-restricting polysaccharides within the primary wall. It is probable that ATPase-stimulated H^+ release after 2 and 3 days of growth was sufficient to lower the pH to the desired values so that it could continue to activate the required enzymes for considerable periods of seedling growth.

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Palynotaxonomical affinities of Lythraceae with Myrtales and Onagrales

The angiospermic family Lythraceae has generally been treated under the order Myrtales. Hutchinson[1] segregated dicotyledonous plants into Lignosae and Herbaceae, placing the family under Herbaceae in association with mostly epigynous taxa like Onagraceae, Haloragaceae, Trapaceae and Callitrichaceae of the order Onagrales. While revising his classification for the third time, Hutchinson[2] reconsidered the family under Lignosae and treated it under the order Myrtales in association with the Sonneratiaceae, Rhizophoraceae, Lecythidaceae, Combretaceae and Melastomataceae with a closer relationship with the last two families. Hutchinson[2] also considered the Myrtales to have originated from the Guttiferales. Stebbins[3] rearranged these families and placed Onagraceae and Trapaceae under the Myrtales and Haloragaceae and Callitrichaceae under other orders. Takhtajan[4] merged both the Hutchinsonian orders under Myrtales and placed the families like Lythraceae, Sonneratiaceae, Melastomataceae, Myrtaceae, Onagraceae, Trapaceae, etc. under the suborder Myrtineae. The object of the present work is to sort out the prevailing unstable relationships of the family Lythraceae based on pollen-morphological characters.

A total of 35 species under 31 genera from ten families have been investigated. The pollen morphology of the relevant families was studied and described with special reference to aperture, shape, size, exine ornamentation and stratification. Such characteristics of the relevant families, six from Lignosae and four from Herbaceae of Hutchinson[2] revealed considerable variations (Table 1).

Pollen-grains of six arboreal families have mainly been found to be colporate. *Duabanga grandiflora* of the Sonneratiaceae, having close affinity with the Myrtaceae and Lecythidaceae, however, revealed the presence of triporate grains. On the other hand, out of four herbaceous families, porate apertural types were recorded from three families except from the

TABLE 1 : Pollen-morphology of the taxa of Lythraceae and associated families under Onagrales and Myrtales, i.e. under Herbaceae and Lignosae respectively (after Hutchinson, 1973)

Name of the plant 1	Family 2	Habit 3	Shape 4	Apertural Character 5	Surface Ornamentation 6	Measurements of the grain PA/ED 7	Measurements of the aperture (colpi, L/B)(pores,L/b) 8
Class-Herbaceae							
Order-Onagrales							
Callitriche heterophylla Pursh, Fl. Am.	Callitrichaceae	Annual herb	Prolate-spheroidal	Inaperturate	Finely reticulate	25.5/24.0 µm	
Haloragis alata Jacq.	Haloragaceae	Herb	Spheroidal	Tetraporate	Finely reticulate	Diam. of the grain 33.0 µm	5.25/9.0 µm
H. micrantha R. Br. ex Scib. et Zucc.	"	Herb	Spheroidal	Tetriporate	Finely reticulate	Diam. of the grain 31.5 µm	3.75/4.5 µm
Epilobium cylindricum D.Don	Onagraceae	Herb	Oblate-spheroidal	Triporate	Reticulate	75.0/78.0 µm	15.0/9.0 µm
Fuchsia dependens Hook.	"	Herb	Oblate	Biporate	Reticulate	28.0/44.0 µm	Diam. of the pore 10 µm
Jussiaea repens Linn.	"	Aquatic Herb	Oblate	Triporate	Reticulate	76.5/82.5 µm	Diam. of the pore 21.0 µm
Oenothera erythrosepala Borbás	"	Herb	Peroblate	Triporate	Reticulate	76.0/92.0 µm	52.5/64.5 µm
O. rosea Aiton.	"	Herb	Peroblate	Triporate	Reticulate	78.0/90.0 µm	24.0/28.0 µm
Trapa natans Linn.	Trapaceae	Aquatic Herb	Oblate	Triporate	Reticulate	75.0/82.0 µm	22.5/15.0 µm
Class—Lignosae							
Order—Myrtales							
Anogeissus latifolia (DC.) Wall. ex Beddome.	Combretaceae	Tree	Sub-prolate	Tricolporate	Reticulate	16.5/13.5 µm	13.5/1.5 µm
Calycopteris floribunda (Roxb) Poiret	"	Tree	Sub-prolate	Tricolporate	Psilate	30.0/27.0 µm	21.0/2.2 µm
Combretum decandrum Roxb.	"	Large shrub	Sub-prolate	Tricolporate	Psilate	22.5/19.5 µm	18.0/1.5 µm
Lumnitzera racemosa Willd.	"	Small tree	Prolate	Tricolporate	Reticulate	27.0/21.0 µm	22.5/3.0 µm
Terminalia alata Heyne ex Roth	"	Tree	Sub-prolate	Tricolporate	Psilate	16.5/13.5 µm	13.5/1.5 µm
Terminalia bellirica (Gaertn.) Roxb.	Combretaceae	Tree	Sub-prolate	Tricolporate	Psilate	22.5/18.0 µm	18.0/1.5 µm
Barringtonia acutangula Gaertn.	Lecythidaceae	Tree	prolate	Tetracolpate	Recitulate	49.5/37.5 µm	40.5/6.0 µm
Couroupita guianensis Hook.	Lythraceae	Tree	Sub-prolate	Tricolporate	Reticulate	36.0/30.0 µm	30.0/1.5 µm

TABLE 1 (continued)

1	2	3	4	5	6	7	8
Lagerstroemia reginae Roxb.	Lythraceae	Tree	prolate	Tricolporate	Reticulate	45 0/37.5 µm	36.0/4.5 µm
Lawsonia inermis Linn.	"	Shrub	Sub-prolate	Tricolporate	Psilate	19.5/16.5 µm	16.5/1.5 µm
Lythrum virgatum Spreng. ex DC.	"	Shrub	Prolate	Hexacolporate	Striato-reticulate	48.0/40.0 µm	37.5/3.0 µm
Punica granatum Linn.	"	Tree	Prolate	Tricolporate	Psilate	25.5/19.5 µm	21.0/1.5 µm
Rotala rotundifolia (Roxb.) Koehne	"	Herb	Prolate-spheroidal	Tricolporate	Psilate	19 5/18.0 µm	16.5/3.0 µm
R. salicifolia (Montu ex Bl.) Koehne	"	Herb	Sub-prolate	Tricolporate	Psilate	18 0/12.0 µm	12.0/1.5 µm
Melastoma malabathricum Linn.	Melastomataceae	Shrub	Sub-prolate	Tricolporate	Psilate	24.0/22.5 µm	21.7/3.0 µm
Memecylon edule Roxb.	"	Tree	Prolate-spheroidal	Tricolporate	Psilate	16.5/15.0 µm	15 0/1.5 µm
Osbeckia chinensis Linn	"	Shrub	prolate	Tricolporate	Psilate	25.5/18.0 µm	22.5/1.5 µm
Oxyspora Paniculata (D.Don.) DC.	"	Shrub	Sub-prolate	Tricolporate	Psilate	16 5/13.5 µm	13 5/1.5 µm
Sarcopyramis napalensis Wall.	"	Shrub	Sub-prolate	Tricolporate	Psilate	30 0/27.0 µm	25.5/1.5 µm
Eucalyptus globosus Labill.	Myrtaceae	Tree	Sub-oblate	Parasyncolporate	Psilate	25.5/30 0 µm	10.5/1.5 µm
Eugenia uniflora Linn.	"	Tree	Oblate	Syncolporate	Finely-reticulate	16.5/19.5 µm	9.0/1.5 µm
Melaleuca leucadendron Linn.	"	Tall tree	Prolate-spheroidal	Tricolporate	Psilate	16.5/13.5 µm	13.5/1.5 µm
Duabanga grandiflora (Roxb.) Walpers.	Sonneratiaceae	Tall tree	Sub-prolate	Triporate	Reticulate	25.5/21.0 µm	Diam. of the pores 4.5 µm
Order—Guttiferales							
Calophyllum inophyllum Linn.	Hypericaceae	Tree	Prolate-spheroidal	Tricolporate	Reticulate	39 0/37.5 µm	18 0/3.0 µm
Hypericum himalaicum N. Robson.	"	Herb	prolate	Tricolporate	Psilate	22.5/18.0 µm	19.5/1.5 µm
Norysca hookeriana (Wt. et. Arn.) Wt.ex Y. Kimura	"	Shrub	Prolate-spheroidal	Tricolporate	Reticulate	18 0/16.5 µm	15.0/3.0 µm

P.A. = Polar axis, E.D. = Equatorial diameter. L/B = Length/Breadth

Callitrichaceae, where the grains were inaperturate. Pollen-grains of the Lythraceae have been generally found to be tricolporate— a character common with the allied families of the Lignosae, *Barringtonia acutangula* of the Lecythidaceae, however, showed a departure from the general trend having colpate pollen-grains. Prolate-tricolporate grains of the members of the Lythraceae are very similar to the grains of Melastomataceae, suggesting close affinity as considered by Hutchinson[2]. His tracing the origin of the order Myrtales from the Guttiferales derive support from the pollen-morphological data. Pollen-grains of *Calophyllum inophyllum* and *Hypericum himalaicum* of the Hypericaceae bear more or less same type of tricolporate pollen-grains.

It may be concluded from the pollen-morphological studies of the associated families of Lythraceae pertaining to Hutchinson's later treatment[2] that the family is more logically placed under the class Lignosae. The findings also support Hutchinson's idea about the origin of the order Myrtales from the Guttiferales.

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Isolation of furfuraldehyde from aldobiuronic acid of Bhindi fibre (*Hibiscus esculentus* Linn.)

Bhindi fibre is a vegetable fibre which is a by-product from the waste of Bhindi pod cultivation. It has got immense potentialities as a source of commercial value[1], such as making paper, cardboard and Textile purposes. Before a fibre is advocated for its industrial and other uses its chemical nature need to be properly ascertained. This work was done with the idea that the yield of furfuraldehyde from this compound would correspond more closely with the yield to the expected from the acidic component of the parent polysaccharides. The results are reported here.

Aldobiuronic acid is the acidic part of the polysaccharide of the Bhindi fibre. It was isolated by acid hydrolysis (0.5M H_2SO_4) of hemicellulose and examined by g. l. c[3]. It was observed that a small amount of xylose was present in the acidic sugar. Removed the trace amount of xylose by paper chromatography with the solvent system butanol, pyridine, water (10:3:3). The aldobiuronic acid was extracted from the paper with water and the solution was treated with Amberlite rasin IR-120 (H^+) filtered and concentrated to a syrup under reduced pressure. The syrup was dried to a powder in a vaccum desiccator over phosphorous pentoxide.

The aldobiuronic acid had $(\alpha)_D^{30}+ 97$, (C, 1.05 in water) OMe 9.32%, uranic anhydride 51.2%, equivalent weight 338.5. Calc. for $C_{12}H_{20}O_{11}$, OMe 9.1, uronic anhydride 51.76% equivalent weight 340.

The aldobiuronic acid was identified as 2-0-(4-0-methyl-α-D-glucopyranosyl uronic acid)-D-xylopyranose, also by its conversion into its acetate and its to the methyl ester methyl glucoside[4][m.p. 200°C, $(\alpha)_D^{30}+ 100$ (c, 0.55 in chloroform) OMe, 17.1].

Furfuraldehyde was obtained[5] by boiling the aldobiuronic acid with 12% Hel at 145°C until no further reaction for furfural is given by aniline acetate. The furfural was precipitated as phloroglucide and calculated from the weight of phloroglucide using Krober's table. In our experiment 40.0 mg of aldobiuronic acid gave 23.3 mg of furfural-phloroglucide. It shows that 4-0-methyl glucouronic acid residue evolves 15.04% of its weight of furfural. On glucouronic anhydride the yield is 16.24%, which is 29.77 of the theoritical value.

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On the mass transfer during intercellular communication

According to the fluid mosaic model of membrane structure[1], surface proteins are free to diffuse in a lipid matrix and thus to assume a random or homogeneous distribution over the cell surface. Lipids and proteins are mobile in the plane of the membrane[2]. This lateral mobility[3] could have an important role in the transmission of signals through the membrane. Cell-to-cell communication consists of both long-range and short-range interactions between cells[4]. Cell-to-cell diffusion of substances is involved in the signal transmission[5]. Macromolecules could pass between cells by going through membrane junctions between the cells.

The interfacial motion between nucleoplasm and cytoplasm has recently been studied[6]. The cell pulsates and the surface area is assumed to change according to the relation[6]

$$S = S_0 (1 + \alpha \sin^2 \omega t), \qquad (1)$$

where S_0 is the interfacial area at $t = o$, $\omega = 2\pi f$, f is the frequency of vibration, $1 + \alpha$ is the ratio of maximum area, S to minimum area, S_0. (The surface area is more dependent than the volume on fluctuations from an idealized cylindrical or spherical cell form[7]). As the cell pulsates, new macromolecules come to the surface as the area is increased and older ones are removed from the surface as the area is decreased. Thus, there is an exchange of macromolecules from one cell to another. If K be the mass transfer coefficient (mS^{-1}) and D the diffusivity ($m^2 S^{-1}$), the time-averaged mass transfer product can be written as

$$\frac{\overline{KS}}{S_0} = (D/\pi)^{1/2} \frac{1}{t'} \int_0^{t'} \left[\int_0^{\tau} F(t) \frac{d(S/S_0)}{dt} dt\right] d\tau$$
$$+ 2 (D/\pi t')^{1/2}, \; F(t) = (\tau - t)^{-1/2} \qquad (2)$$

The first term gives the transfer to macromolecules which appear or disappear whereas the second term represents transfer to the macromolecules of the surface membrane present over the entire time period t'. (The plasma membrane has a vital role in intercellular communication[8]). $\overline{KS}$ is the time average product of interfacial area and external mass transfer coefficient. Using equations (1) and (2), one gets

$$\frac{\overline{KS}}{S_0} \quad \frac{\sqrt{2 D\omega}}{\pi} (1 + 0.7 \alpha), \qquad (3)$$

assuming that the averaging time is the period of oscillation of the cell, f^{-1}. Mass transfer is thus directly related to the frequency of vibration of the cells and the amplitude factor α. Taking $\alpha = 0.5$, $\omega = 0.22 \times 10^6$ Hz, D for viscous cytoplasm[9] $= 1.2 \times 10^{-11}\ m^2 S^{-1}$, one gets

$$\frac{\overline{KS}}{S_o} \simeq 1 \times 10^{-3}\ mS^{-1}.$$

Mass transfer during intercellular communication involves a number of fundamental biological processes that may have relevance to human disease[10]. Disorders of membrane fluidity may be the underlying cause of several metabolic diseases[11]. Changes in the cell membrane are responsible for malignant growth[11]. If the intercellular communication is cut off and the junctional membranes are sealed, the behaviour of normal cells becomes that of cancer cells[5].

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Red-vented bulbul (*Pycnonotus cafer*), a serious pest of Brinjal in Murshidabad

Birds are often considered to be beneficial as they are natural regulators of insect populations[1-3] but now it is regarded as a serious pest, capable of destroying young crops[4,5].

In Murshidabad, a district of West Bengal red-vented bulbul, *Pycnonotus cafer* (Aves, Pycnonotidae) became a serious pest of brinjal crops (*Solanum melangena*). The bird is almost black in colour with a small crest and a tuft of red feathers in the anal region. They are mostly active during September, October and November in the brinjal field.

They damage the crop by eating the young fruits. Partly eaten fruits became deformed and market value is thus reduced. Table 1 shows that field I during all three months were mostly affected while crops of field II were less damaged (12.77% in field I and 9.38% in field II in yield and 18.99% in field I and 13.03% in field II in rupees, derived from Table 1). Actually when the birds were driven away by the guards they took temporary shelter in the nearby trees of field I while in the field II they have to flown away for a more longer distance. When the guard went to a distant field, the birds again came back quickly in the nearby field I while they took more time to reach field II. Thus the gap between successive visits was less in field I than field II and so the damage became maximum in field I. However, statistically losses incurred in two fields do not differ significantly (Chi-square values for the months of September, October and November are 1.839, 2 and 0.866 respectively against the table value 3.841).

Beating of drums either mechanically or manually to produce sound or by erecting an effigy of a man in the middle of a plot are in vogue in Murshidabad. But the last method proved to be ineffective as the incidence of attack reaches maximum within 2 or 3 days after erecting the effigy. Poison baiting though effective but it was not favoured because it may cause serious eco-

TABLE 1 : Composition of loss of brinjal crop (in yield and in rupees) from red-vented bulbul in Murshidabad (Field I, adjacent to trees; Field II, Open)

Measures	Months					
	September		October		• November	
	Field I*	Field II*	Field I*	Field II*	Field I*	Field II*
Total yield of unattacked fruit (kg)(U)	5250	5550	7350	8123	4900	5052
Total yield of attacked fruit (kg)(A)	875	500	1138	652	350	195
Expected yield (kg) (E)	7440	6850	9626	9818	5705	5481
Actual loss (kg) (E–(A+U) = Ly)	1315	800	1138	1043	455	234
Per cent loss (kg) Ly x 100	17.67	11.68	11.82	10.62	7.96	4.27
Selling price of unattacked fruit (@ Rs. 2.00 per kg) (SU)	10500	11100	14700	16246	9800	10104
Selling price of attacked fruit (@ Rs. 0.80 per kg) (SA)	700	400	910.4	521.6	280	156
Selling price of expected fruit (@ Rs. 2.00 per kg) (SE)	14880	13700	19252	19636	11410	10962
Actual loss (Rs.) (SE–(SA+SU) = L_r)	3680	2200	3641.6	2868.4	1330	702
Per cent loss (Rs.) $\frac{Lr \times 100}{SE}$	24.73	16.06	18.92	14.61	11.66	6.40

*Based on 25 plots, samples were taken at 4 days interval

logical imbalance by killing some useful birds and other vertebrates.

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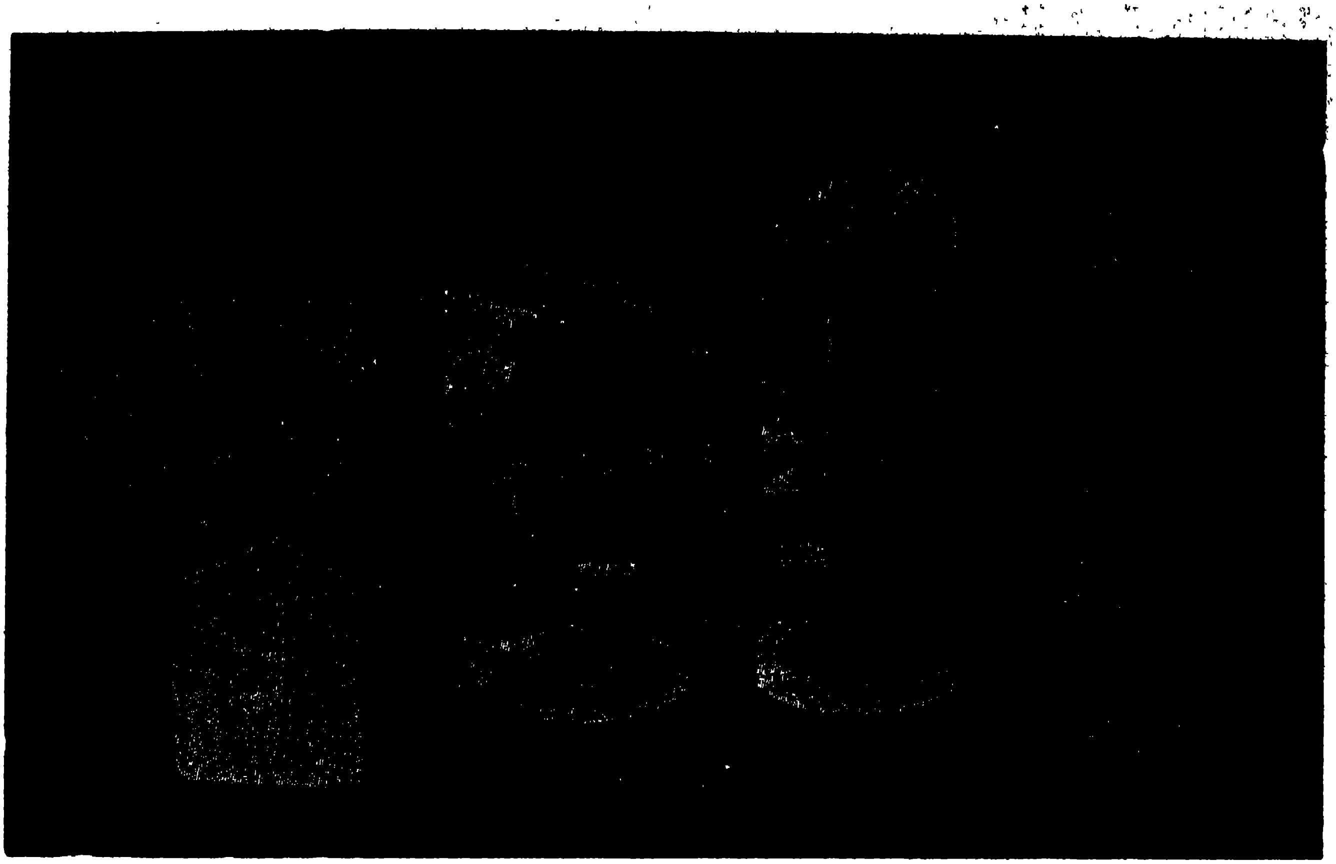

OPTICAL GLASS

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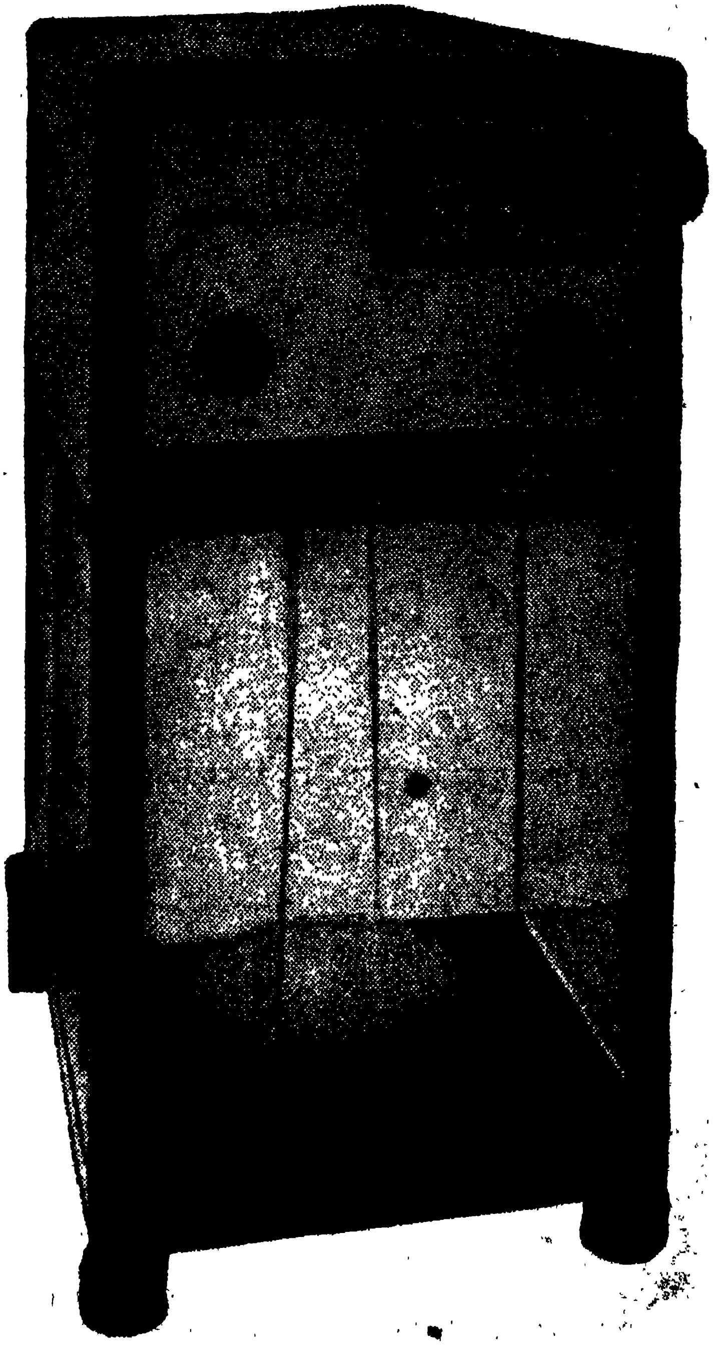

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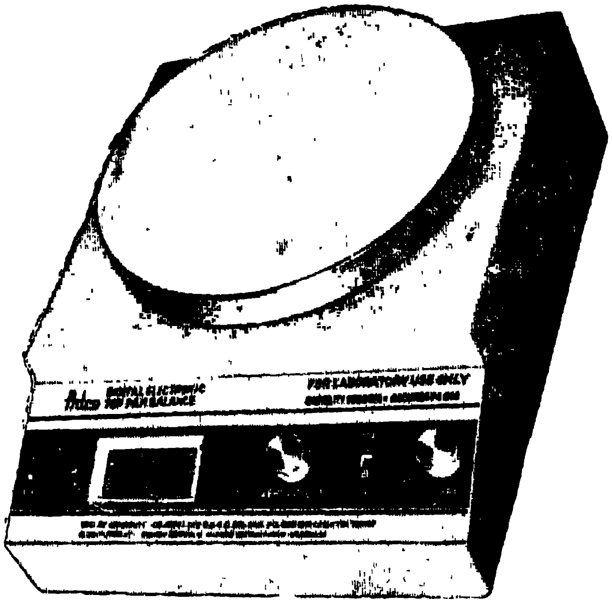

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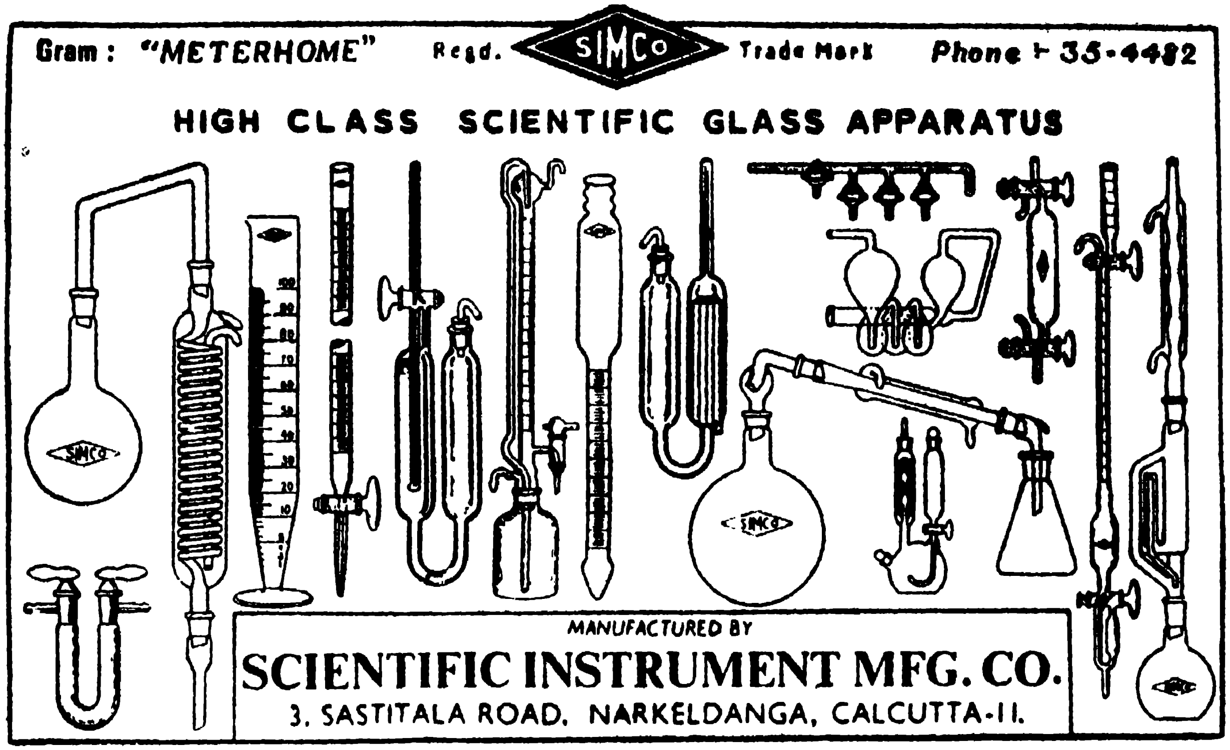

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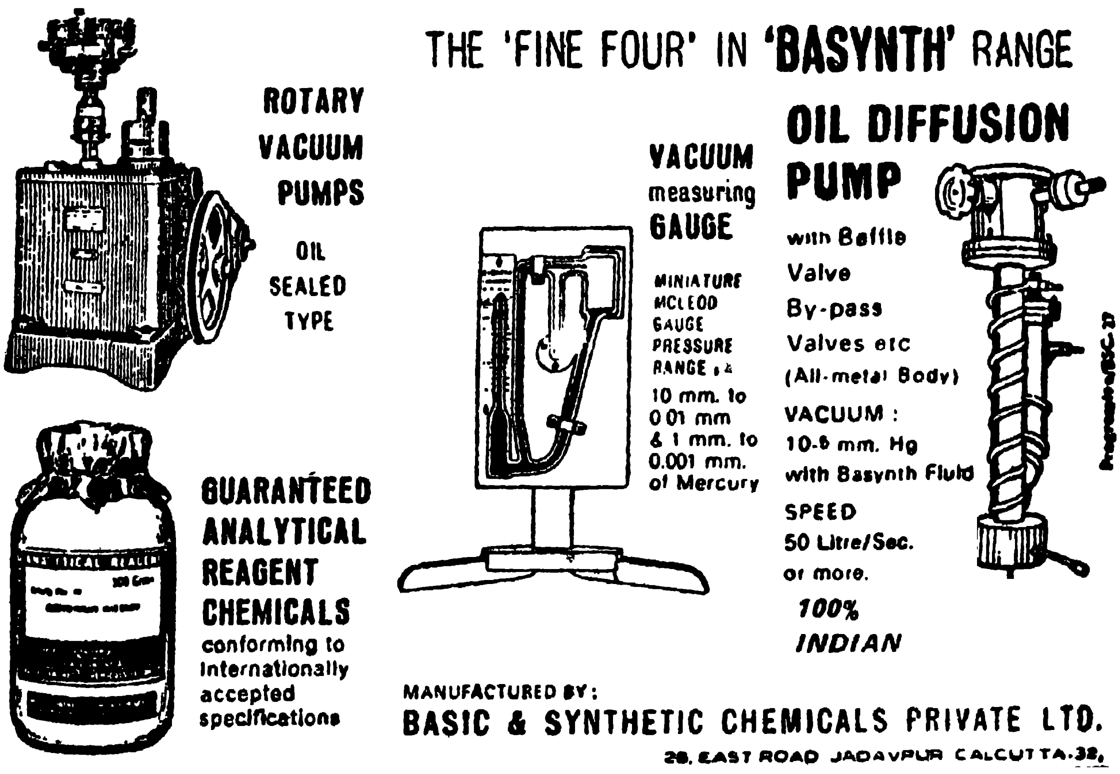

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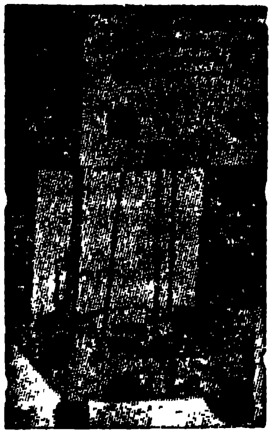

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ENVIRONMENTAL PROBLEMS VIS-A-VIS FORESTS OF INDIA*

A DECADE ago, Richard St. Barbe Baker, an international authority on forestry, remarked that it was essential to preserve and grow more trees to save mankind from extinction. Delivering a talk on "Destroy Trees, Destroy Civilisation" under the auspices of Himalaya Seva Sangha in New Delhi, he stated that the preservation of forests was no longer a national problem, but a global one. This had to be tackled on a massive scale and the sooner it was done the better for mankind, he added. The earth is being skinned alive and ruthlessly at that. This has caused a timber famine in the world and the day is not far off when we will run short of fuel, food, oxygen and water. The problem, according to Baker, had never been so serious as at present, for forests were being "mowed down to feed the requirements of industries without any regard to the consequences". He was aggrieved to find the once-graceful green mantle of the Himalayan ranges going barren now. He pleaded for cooperation among India and its neighbours to preserve and develop the mountain ecology for a better life for the people.

Tehri Dam

It is amazing that, though trying to protect natural resources, the Centre still approves projects whereby vast tracts of forest are damaged. A case in point is the Tehri dam project which might inundate not only the town of Tehri entirely but also 72 other villages partially. It will flood 2,000 acres of pasture, 1,600 acres of cultivated land and 1,000 acres of forest land. While the project is expected to generate 2,400 MW of electricity, it will displace about 70,000 people. Moreover, doubts have been expressed about the dam's location in a seismologically sensitive zone. The very purpose of the dam would be lost by its construction on the Bhagirathi, a river with unusually high rate of siltation chiefly due to wanton destruction of forests upstream. Despite objections raised by more than one expert committee, the Government has decided to go ahead with the project and only a writ petition filed in the Supreme Court by a local citizen's organisation is holding up the work.

Narmada Valley Hydel Project

The second case is that of Narmada Valley hydel project, one of the most ambitious Government projects, comprising three States which would uproot 90,000 tribals and 284 villages. More than 40,000 hectares (ha) of irreplaceable deciduous forests in a region, harbouring a vast array of wildlife, would be submerged. Recent inquiries in the command area of the project indicated that these victims (people) have not been officially informed what the Government planned to do with them before drowning their farms and homes. If the barrage height is lowered, it will serve the utility of irrigation and also conserve a great patch of Nature for future human use.

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* Based on a lecture delivered at the National Seminar on Environmental Protection held at Visva-Bharati during September 4-6, 1987.

Doon Valley Limestone Quarrying

Of late, the Chipko activists (to whom the Government pays so much lip service) have been trying to stop limestone-quarrying in the Doon Valley of Uttar Pradesh, which has reduced almost the entire Shivalik range to rubble. In 1985, the Supreme Court ordered the closure of most quarries. One of the quarries, located in Nahi Kala village, was allowed to operate and despoiled the environment. The villagers alleged that the experts appointed by the Supreme Court never visited their village. So the villagers are picketing the quarry on the plea that it was ruining forest land and was in contravention of the Forest (Conservation Act, 1980). The villagers have been attacked repeatedly by outsiders. Since the latest incident occurred on March 20, 1987 the police registered criminal cases against villagers receiving the most serious injuries during the attack.

Appiko Movement

Deforestation is, of course, a countrywide phenomenon. The third case being examined is of the now famous Appiko movement in Karnataka, where local farmers even forced the British to allocate reserve forests for them in 1924. These were the areas where large-scale forest-based industries came up after 1947, slowly replacing the forest by monoculture plantations of eucalyptus and teak. In northern Karnataka, the forest cover declined from 81% in 1952 to 20% in 1983. The consequences have been erratic precipitation, drying up of water resources and major crop failures. The Appiko movement was thus ushered in, demanding a stop to commercial felling of trees. Though the demand has been conceded officially, the Government is yet to declare catchment areas as protected forests or even plant indigenous species.

Kaiga Reactor

The fourth case is that of India's nuclear plant to be commissioned at Kaiga, a pristine site on the banks of the Kali in Karnataka's north Kanara district. It is 38 km inland from the Arabian Sea and is hemmed in on three sides by hills that bring 250 cm of rainfall for five months every year. In the heart of a luxuriant tropical evergreen forest, the Department of Atomic Energy (DAE) will set up two units initially, each of 235 MW capacity. There is no cessation of a nuclear pile once you have pressed the button. As the Kaiga reactor will be located near uranium-mining grounds at Arebail, all that goes into the functioning of a reactor will be concentrated in the strikingly verdant Western Ghats. Through the fragile forest belt, the uranium will be carted to Hyderabad. At the plant site, enriched uranium will be fissioned and so will be the waste reprocessing as well as disposal. Such an accumulation of radioactive mess is not likely to prevail anywhere else in the world.

It is a matter of deep consternation that the DAE drew up the blue print for the Kaiga complex without any environmental-impact analysis despite three years of exploratory activity. However, blind work commenced without seeking the consent of the region's few inhabitants. Exploratory drilling and ground-breaking for a helipad have started. Work on power-transmission lines, workers' colonies, townships and link roads is yet to begin. At least 5,000 workers will make the forest their means of livelihood and recreation, compounding the harm. As if this is not enough, the Kaiga project will be put paid to the Anshi wildlife sanctuary 15 km away. Among the fauna perhaps to be disturbed, if not exterminated, by radioactive substances include the sloth bear, spotted deer, wild dog, gaur, monitor lizard, wild pig and tiger. The avifauna likely to be adversely affected are rare birds such as Malabar pied-hornbill, pigmy woodpecker, mynah, Jordon's imperial pigeon, long-billed vultures and some 120 other species. On the agricultural front, the nuclear plant will be definitely detrimental to plantation crops like arecanut, betelvine, cardamon, cocoa, coconut and pepper.

All these lead to the crux of the problem: what is the long-term future of the Western Ghats once the Kaiga nuclear plant comes up ? An accident or a bomb can irreversibly damage the ecosystem for generations to come and the world may witness an unprecedented ecological disaster which can eclipse the incident at Three Mile Island (USA) or Chernobyl (USSR).

Bastar Forests

On the question of deforestation, the Second Citizens' Report (1985) on the Environment (prepared by the Centre for Science & Environment, New Delhi, in collaboration with 24 voluntary organisations and 54 social workers, environmentalists and scientists from all over the country) pointed out the discrepancy between Government data and the data subsequently revealed by satellite pictures by which it was proved that India is losing a staggering 1.3 million ha out of a scanty tree cover that currently accounts for merely 7.5% of the country's land area. Further depletion of this tree cover would spell disaster for posterity. If environmental restoration work is initiated in right earnest now, it would take more than 100 years or three human generations to resolve the ecological crisis confronting us.

The above report dealt specifically with the issue of deforestation in Bastar. It mentioned that approximately 80% of forests are estimated to be adequately stocked, but about 400,000 ha of largely undemarcated and protected forest land is thoroughly degraded with only a bare minimum of top soil. "A number of efforts have been made in Bastar to grow monoculture plantations to meet the needs of wood-based industries. Efforts at raising pine and eucalyptus plantations have been utter failures, but the conversion of sal forests into monoculture continues to be state policy". Among the influences of deforestation, the report stated one that is not normally focussed upon the ruin of several traditional crafts due to the paucity of raw materials.

Eucalypt & Leucaena Episode

The eucalyptus, one hailed as a panacea for all forestry problems, appears to be declining from grace. That farmers in Punjab and Gujarat switched over from raising food-grains to this wonder tree and got rich in no time had set off an eucalyptus revolution in many States. With generous official assistance, nearly a million ha of good farmland is thought to be devoted to this enthusiastic drive. In recent years, environmentalists and foresters have started ringing the warning bell that the tree performs considerable harm by withdrawing moisture from the surrounding soil which harms proximity crops. In 1985, a Seminar at the Kerala Forest Research Institute enumerated many other perils and advocated caution in propagating eucalyptus which provide an excellent resource for fuel, paper and what have you. This reminds me of subabul (*Leucaena Leucocephala*) which only a few years ago was cited as a miracle plant. In 1981, a Seminar at Urlikanchan near Pune indicated some major demerits and not much has since been heard about it. The quest for a fast-growing tree that would produce a green cover to the soil and serve as a primary source of fuel and commercial energy cannot be a simple one in terms of India's dimension and variety. What such a plant takes away from the soil must be put back into the soil. Like high-yielding cereals, fast-growing tree plantations will require more fertilisers and water from outside. Moreover, there is a native resistance of the soil to exotic plants and the local flora are not congenial to immigrant species.

Famine

Another case examined is deforestation in the Santhal Parganas of Bihar, 70% of which was dominated by thick forests two decades. Today, the forest cover has plumetted down to 14% and the bulk of it eucalyptus and teak grown commercially but of little use to the local populace. The consequences are inevitable: famine, water scarcity and diseases hitherto unknown in the region—cholera, jaundice and malaria.

Resident protests are denounced as a law-and-order problem.

Vegetation degradation in West Bengal

The Left Front Government, which until recently was under the impression that West Bengal had 18% of its area under forests, got a jolt when satellite studies by National Remote Sensing Agency demonstrated that it was only 8%. The State is galloping towards an environmental disaster as far as rapid destruction of forest areas are concerned (in the name of industrialisation).

The important reason for brazenly destroying forests is rural poverty, bringing about untold suffering and misery. Fodder and firewood are becoming expensive these days. Those villagers who live in the fringe areas of the forests are paid by the timber-thieves to guide them into the forests. They are forced by agrarian exploitation and lack of round-the-year employment to cut down trees mercilessly. A grown sal tree is known to fetch Rs. 10,000-12,000. Such high prices attract the poor people to commit the most heinous crime. According to the most conservative official statistics, more than 40,000 crimes have been detected over the past three years. Of these, 85% constitute illegal felling of trees. An equal number of cases, if not more, have gone untraced.

Illegal felling of trees by organised groups has gone up by leaps and bounds with enhanced demand for timber and firewood. The Government has so far failed to bring the culprits to book or even contain the menace. Honest Forest Department Officers have incurred the wrath of interested politicians for trying to apprehend known culprits. Frequently, these clandestine gangs overpower the handful forest guards and have access to the core areas of forests on account of improved communication facilities. The gangs saw a healthy tree halfway into its girth at the bottom. Though the saw-mark is scarcely discernible, the tree dies quickly. It is then consumed to legal chopping by foresters. Every year, wood valued at Rs. 200 crores is felled illegally. In West Bengal alone, the annual consumption of timber is 10.4 million m^3. There is a recorded supply of 700,000 m^3 of timber per annum and the deficit is made up by procuring through improper means of unscrupulous traders.

Due to population explosion, the widely acclaimed sal forests (extending from Midnapore to Purulia through Durgapur and Bankura) is now virtually non-existent. Even the Sunderbans, the world's elegant mangrove forest, is endangered for the same reason. The forests of Jaldapara, abode of the renowned one-horned rhinoceros, are on the wane. More and more forest land is encroached upon and cleared for new villages.

However, there is little attention paid to modify the development process in a fashion that would bring it into great harmony with the needs of the people and maintain ecological balance simultaneously. How forests exactly regulate the condition of air, water and soil has been illustrated in the districts of Bankura and Purulia. These two districts were heavily infested with forests 50 years ago and trees are a scarce commodity there today. As a result, the soil has turned parched and now need more water than before for cultivation. Whereas the water requirement of soil has gone up, the water level has fallen drastically because of death of trees which store the water underground and serve as a percolating medium. In years of poor rainfall, the water instead of percolating down goes waste. Hence, most of the saplings tend to wilt for want of moisture.

Till now, 80% of the seedlings supplied under the afforestation programme by the Government are of two exotic species—eucalyptus and subabul. The former is of limited commercial significance and can run to the size of a plantation but cannot create a forest in view of the fact that multiplicity of mixed species is indispensable for maintaining Nature's balance. Such a monoculture afforestation policy of the State Government has been criticised on the ground that eucalyptus is not suitable for the development of a fauna, as it can spoil the food-chain of animals.

The dwindling of vegetation cover causes the loss of top soil—a natural resource virtually irreplaceable and taking Nature 1,000 years to build up an inch. The drought-flood cycle is getting accentuated, posing a new threat to the ecology. "Recharge of the groundwater is being reduced and as a result villagers are finding it difficult to get drinking water during the dry months". Thus, trees are urgently needed to help in storing underground water. It is noteworthy that for every 7 km of forest area, 1 km is denuded yearly.

Though Central funds are earmarked for forest development in hill areas, there is barely any evidence of integrated approach to the district of Darjeeling. The concept of development without destruction, so essestial for conservation and utility of resources, is yet to strike firm roots there. Hence, the region finds itself in the midst of a grim situation in which a depleted resource base and mounting poverty reigns supreme. By and large, the forest policy is geared to restructuring the vegetation through the introduction of quick-growing exotics regardless of the impact of such undesirable practices. Apart from denudation, the forest-based life-style of the target groups (whose economic regeneration is the avowed goal of the Five-year Plans) has been undermined by this process. Furthermore, the commercial exploitation of the Darjeeling forests ignores the conservation of wildlife. It is a pity to see Himalayan bears, wild boar, deer, jungle cat and leopards restricted to a few acres of the Senchal wildlife sanctuary—a run-of-the mill tourist show-spot rendered smaller in size by indiscriminate deforestation. A rational forest policy would have concentrated on an effective conservation in the catchment areas, particularly the dense woods of Tiger Hill and Takdah as well as protection of the inaccessible natural sanctuary and watersheds of the Takdah range. Since the Himalaya is geologically young, the Darjeeling hills are susceptible to erosion and are in dire necessity of being clothed with forests. A proper afforestation programme has a conspicuous role to play here.

Conclusions

The major sufferers of environmental degradation are women, as it is they who have to spend much longer hours collecting fuel wood and fodder and then cook in inefficient stoves which ruin their health. Probably for this reason, whenever there is an afforestation programme, the maximum co-operation is received from the womanfolk. When women plant trees, they like to plant those which yield fuel and fodder and not cash crops like eucalyptus.

As repeated visits to the regions worst affected by the destruction of environment have depicted, the local people do not need an awareness programme or almost no villager in India need training in conservation ethics. It forms a part of their daily lives and they are very well aware of it. It is the city-bred man and the bureaucrat and legislature who need to be tutored on conservation education. What rural people need is the political voice to express their own heritage, rooted in conservation. They are usually powerless to halt the demolition ordered from "outside". When villagers talk of environmental protection, they mean their own survival. Their conservation movements are deeply entrenched in the country's own highly developed heritage. The residents of Bastar did not need to launch environment awareness campaigns or hold eco-development camps to resist tropical pine plantation in their forests. They knew that monoculture wrought havoc for the precious environment and for them too. The same goes for the Bodhghat project, which the Government of Madhya Pradesh seems to have pushed through hurriedly despite fierce local resistance and a harsh report from the Ministry of Environment and Forest. □

S. C. Datta

BIOTIC COMMUNITIES IN ENDANGERED AQUATIC AND MANGROVE ENVIRONMENT

A. B. CHAUDHURI*

Introduction

WHILE the orbitting Satellites have contributed greatly to our knowledge of cloud cover, cloud-top-temperature, vertical temperature, humidity level at different altitudes and Remote Sensing Satellite on Ocean temperature and Geostationary Satellite on weather developments, these Satellites have not adequately reflected data on moisture level of various types of soils and the biologists have not either correlated such findings with occurrence of microflora and fauna.

The Department of Space has only recently staged a symposium at Ahmedabad and some years back the National Science Academy held a workshop of hydrology; such studies have not been done on floral and faunal occurrence vis-a-vis moisture regime.

International Union for Conservation of Nature and Natural Resources (IUCN) offers a broad definition of Wetland as "Areas of submerged or water stagnant lands whether both natural or artificial or permanent or temporary or whether the water is static or flowing or fresh, brackish or salt-water dominated areas to be considered would include-marshes, sloughs, bogs, swamps, fens, peatlands, estuaries, bay, lagoons, ponds, lakes, rivers, springs & reservoirs; where marine or coastal waters are involved water upto a depth of 6 m at low tide are included".

Wetlands in this country have shrunk considerably and there are endangered sites in all biotic communities and ecosystem. Highly productive wetland have been and are being destroyed for dredging, filling, mining, pollution, expansion of cultivate and habitation.

What are Wetlands ?

Wetlands are economic reserves. They are for breeding, nesting, moulting and wintering by migratory birds. Such lands function as sponges accumulating excess water in flood and are important for the maintenance of groundwater level. Marshes and swamps act as safety valves in the whole hydrographic system of a watershed area. Such lands are complete ecosystem and form vital sites for game birds of high genetic value. Ramsar convention of IUCN had been an initial step to identify such endangered and rich sites of the world. This convention has emphasised that wetlands are vital links in the web of life and are sole habitats for several endangered species of local and migratory birds. Such sites have diverse, aesthetic and intangible values and provide fodder, forage and nesting sites for various avifauna and animals. Wetlands throb with faunal life and form nursery for very many aquatic animals and plants. Ponds are, however, the largest aquatic resources of the country. But inland water, ground water, fresh water of rivers, tanks etc., estuarine swamps, high altitude glaciers also form the bulk of wetland.

Identification of Sites

It has been possible to identify and map large dam sites reservoirs, wet wildlife sanctuaries, mangrove forests, back-waters lagoon, but what are about innumeable smaller sites, bils which are created during monsoon, high-altitude small spots of water and moisture-laden sites scattered all over the country ? What is about the moist soil all over the country that harbour millions of invertebrate fauna which have not been identified. It is also necessary to mark out areas of rare plants, endangered plants, concentrated zones of Myxophyceae, Chlorophyceae and Bacillariophyceae, areas of concentration of molluscs, crustacea rich intertidal floral and faunal zone, rich zones of foraminifera, noctileuca and dinoflagellates and also identifying concentrated zones of Plantanista and Crocodylus porosus in the Sunderbans ?

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Water Surface

A FAO expert on Inland Fisheries in South-Eastern Asia was asked by the author about the extent of inland water surface of India. He observed "Some one in long past gave a figure and that was being quoted; there was no authentic basis of such data."

According to the report of Indo-Pacific Fisheries Council (IPFC, 1952), inventory of aquatic surface (km^2) was made for the Country as follows :

(i) Fresh-water pond	-	3,379 km^2
(ii) Brackish-water pond	-	26.7 km^2
(iii) Natural Lakes	-	1,800 km^2
(iv) Artificial Lakes	-	7,258 km^2
(v) Rice fields	-	57,644.2 km^2
(vi) Estuaries/Lagoons	-	2,644 km^2

Taking it for granted that these figures have a sound basis. There is no figure on (i) aquatic sites in glaciers and in alpine situation; (ii) aquatic sites among rocks and boulders; (iii) aquatic sites in crevices of rocks; (iv) temporary aquatic sites during monsoon period and (v) moisture regime in various types of soil and status of underground water at various seasons.

. The figure quoted by I. P. F. C. seems to have some lacunae, as they quote Thailand and Indonesia which have 61,868 km^2 and 1,35,480 km^2 of water surface respectively; India is many times larger than Thailand and have just a little more water surface.

A survey carried by the Forest Department, West Bengal shows that the State (within Reserve and protected Forests) has 57,644 ha of Wetland. In 24-Parganas District (Outside R.F.), the Land and Land Revenue Deptt. have identified 1050 ha of marshes and bils which seems to be very poor. There are many bils outside Reserved in protected forests in the districts of Murshidabad, Malda and West Dinajpur.

National Parks of Wild Life Sanctuaries in marshy and aquatic sites

At least twenty five (25) Wildlife Sanctuaries and National Parks have been established in India on such sites. Notable among these are Lake Pulicut (a lagoon), Lake Chilka (a lagoon), Point Calimere, Vedanthangal, Gillangudi and Ghana. Others are Nealampalli, Manjira, Kolleru, Corinaga, Mahavira Harina Vanasthali, Nalsarovar, Sultanpur, Gobind Sagar, Ghataprova, Ranganathitoo, Sirpur, Gandinagar, Keibul Lamjao, Bhitar Kanika, etc. Several other sanctuaries have ponds and dam sides or river inside; some such areas are Corbett National Park, Sibpur National Park, Taroba National Park and Ranthambhore Tiger Reserve. The largest water area, however, is in Mangrove forests of West Bengal (about 4,500 km^2).

Aquatic and marsh plant resources of India

This country has about one hundred eighty (180, Marshy and Moist sites have another 150 species) species of aquatic plants; these belong to ninety (90) genera and thirty-nine (39) families. There are 9 species of Pteridophytes, 75 species of dicot and 100 species of monocot and vascular plants. The aquatic plants are either floating, or submerged or amphibian or floating with roots at tank bottom. Some salient features are :

(i) Widely distributed species number 35, less widely distributed number 38, restricted number 12, temperate and saline number 24 and restricted species to Indian subcontinent number 35.

(ii) Quantitative abundance of species are *Eichornia crassipes, Leersia hexandra, Trapa bispinosa, Pistia strateotes, Paspalidium geminatum, Scirpus* Sp., *Ottelia alismoides.*

(iii) Temperate saline species are *Aldrovanda vesiculosa, Callitriche stagnalis, Halophila ovalis, Hydrolythrum wallichii, Ruppia maritima, Utricularia inflexa and Zannichellia palustris.*

(iv) Some species restricted to this country are, *Aponogeton echinatus, Limnophila aquatica, L. connata, Myriophyllum tetrandrum, Najas brevistyla* and *Woolfia mircoscopica.*

(v) Heavily exploited species, which form food stuff, are threatened may be endangered soon are— *Nymphaea nouchali, N. stellata, N. alba, N. tetragona, Nelumbo nucifera, Trapa bispinosa, Endydra fluctuans, Ipomoea aquatica.*

(vi) Biologically important species are *Lemna* sp., *Azolla* sp., and *Spirodela* sp. which are avidly eaten by fish as well as bird population. Fruits of most of the species are eaten by aquatic birds, besides leaves. *Azolla* fixes nitrogen.

Utricularia and *Aldrovanda* species which do not occur widely should be protected because of their biological importance and limited distribution.

Najas graminea, a monocot that occurs densely in the swamps of Ranthambhore Tiger Reserve, forms a staple food for Sambars during dry months and needs thorough examination for nutritional value besides its protection.

(vii) There is abundance of occurrence of algal flora in aquatic situation which is also a major component of planktonic flora. As bentic or bottom flora Diatoms are extremely important.

Criteria for identification of Wetland

Ramsar convention (convention of Wetland of International Importance) has fixed some quantitative criteria for identifying wetland of importance to (i) water fowl, (ii) to plants and animals for (iii) assessing the value of representative or unique wetland. A wetland should be considered of international importance if it (a) supports the appreciable number of rare, valuable and endangered species of plants and animals; (b) harbours endemic plant species; (c) maintains the genetic and ecological diversity of a region because of the quality and peculiarities of flora and fauna; (d) has plants and animals at a initial stage of their biological cycle.

It is necessary to evaluate the wetland and marshes according to the criteria fixed by Ramsar Convention. For water fowl of international importance, a wetland should have 10,000 ducks, geese and swam; or 10,000 coots; or 20,000 waders and these should support 1% of individuals in a population of 1 species or 1% of the breeding pairs in a population of one species of water fowl. These criteria put only a few areas under wetland.

Aquatic avifauna vis-a-vis sites

Diversity is the essence of aquatic birds. The story of aquatic bird is the story of water drainage and siltation. Man made ponds have only by-product value for such birds. These wetland sites are a living, dynamic entity and never static, always changing plankton and other vegetation have high nutritive value.

More than one hundred aquatic birds, both local and migrants, visit the aquatic sites all over the country. Specific diversity is high in very many species. Many birds in their breeding season burst into activities to collect food material for their fledglings. Hundreds and thousands of species of vertebrates and invertebrate animals are collected by the breeding birds to feed their fledglings. Various predators prey upon the fledglings and the nature as per selection made on the battle of survival of the fittest.

Myriads of gramnivorous avifauna need wide aquatic surface to wade and swim and they eat leaves, flowers, fruits, stems and roots of various aquatic weeds, phytoplankton and zooplankton.

The requirement of some of the species of birds are specific. It is needless to mention various species of waterben, crake, coot, lapwing, sand piper, shank, gull, tern, cormorant, dirter, Ibis, heron, egret, teal, goose, mallard, shoveller, pintail, white eye, grebe, crane, curlew, plover, jacan-na, slilt, snipe, skimmer, openbill, stork, spoonbill, paddybird, bittern, etc. and some rare and prized birds like flamingo and pelican are integral part of wetland.

Aquatic communities in sub-alpine and alpine hills

At high altitude there are insect associations on stagnant water lake, on fresh-water pools, on salt and alkaline water lake, on torrential streams and on hot springs. There are dearth of surface hunting species of the order Heteroptera and Coleoptera. Some high-altitude pools are of glacial origin. In torrents there are few species, but abundance of individuals. On the shores of lakes extensive association Collembola-Staphylinidae occurs. In hot sulphur spring few species occur (Diptera predominent).

Communities in torrential streams are (I) Ephimerida–Plecoptera association, (II) Denterophlebiidae–Blepharoceridae–Simuliidae association, (III) Chironemedae consociation and (IV) Trichoptera consociation. Nos. (I) and (II) are submerged stone association. No. (I) association has five prominent genera, viz. Bactistron, Eidyurus, Capnia, Nemoura and Rhabdiopleryn.

There are specific insect life on damp lichen and moss covered rocks, wet standing boulders, snow surface, under snow, edges of snow and in glacier creavasses.

Aquatic insects

There are a variety and abundance of insect life in water. They slide and twirl across the silvery expanse of water. The abundance of damsel flies, may flies, caddis flies, dragon flies, and crane flies which form aquatic communities fall prey to the fish, toad and frog and avifauna population. Larvae of aquatic insects can thrive in hot spring, cold-glacial streams and on various other types of waters. Other common insects of ponds and brooks are the back swimmer, the water boatman, the pond skater and the whirligig beetle.

The drying up of a pond is a disaster to aquatic life. Some species can, however, endure by burying themselves in mud bottom and await return of water. Some diving bettles and water bugs are powerful flier and leave drought area when necessary. The importance of aquatic insects that form primary food of aquatic ducklings and insectivorous birds need not be stressed. These aquatic sites need identification and protection.

Aquatic animals

The Gharial (*Gavialis gangeticus*), Water monitor (*Varanas* sp.), the Mugger (*Crocodylus palustris*), Estuarine crocodyle (C. *porosus*), Gangetic dolphin (*Platanista gangetica*), Green turtle (*Chelonia mydas*), Hawkbill turtle (*Eretmochelys imbricata*), Laggerhead turtle (*Caretta caretta*) and Leathery turtle (*Dermochelys coriacia*) are already in the list of endangered species.

Species of turtle and tortoises (*Geomyda, Kachua, Chitra, Testuda* and *Lessemys* sp.) are fighting for their survival in the North Bengal districts and elsewhere for shrinkage of aquatic habitat. Very many species of invertebrates may be noted.

Algae of inland waters

The importance of algae is tremendous in aquatic environment. Myxophyceae play a key role in the hydrobiology of inland water. Some fix atmospheric Nitrogen and can be used as fertilizers in rice field. They can help to purify sewage and polluted waters. Diatoms grow on water poor in nitrates and rich in silica. Chlorophyceae have many fish and invertebrates. Filamentous Zygophyceae such as *Spirogyra* forms floating net and pollutes water as they rot; they also contribute to biological purification in shallow water. A study of *Salvinia auriculata* in Cochin backwaters has shown that the following groups of organisms are associated with it—Nematodes, Annelids, Copepods, Amphipods, Isopods, Ostracods, Deiapods, Insect Larvae Bivalves, Gastropods of fishes.

Areawise distribution of mangrove and estuarine forests are as under : Sundarban mangrove — 4,18,888 ha, Mahanadi delta (Devi and Mahanadi estuaries—12,000 ha, Krishna delta—5120 ha, Godavari delta—13,304 ha, Gulf of Kutch mangrove forests—10,000 ha, Salsitte Island and Western Coast mangrove forests—62,208 ha, Kankinada back waters—33,000 ha, Western Coastal areas—52,616 ha. As such, barring Sundarbans, the mangrove and estuarine forests extend over a very limited area and are very much disturbed. Bulk of these forests have been exploited and felled. Nevertheless, extensive research work has been done on the fauna of sandy shore, clayey shore, beaches and of intertidal benthic and pelagic zones. Pollutions have affected some such coastal and lagoon areas. The forests having no width and being of small patches are very much vulnerable to human depredation.

Phytoplankton of Hooghly-Matla Estuary

Blue-green algae (Myxophyta) distinctly predominate in Hooghly estuary while green algae (Chlorophyta) predominate at upper zones. Most important components are diatoms. At least 50 species of diatoms are common (*Synedra, Coscinodiscus, Surirella, Melosira, Navicula, Diatona, Lauderia, Biddulphia, Bacillaria* are a few genera). Thirty species of Chlorophyta are common (some of the genera are *Pediastrum, Closterium, Cosmarium, Spirogyra, Eudorina, Chlorella, Zygnema, Ulothrix, Volvox, Oedogonium* etc.). Of the 20 species of Myxophyceae *Microcystis, Phormidium, Nostoc, Oscillatoria, Anabaena, Lyngbya* etc. are common genera. There are seasonal variations in the abundance of occurrence of various algae.

Zooplankton of Hooghly-Matla Estuary

Copepods constitute the bulk zooplankton even though rotifers and larval forms out number them. Rotifers, protozoans and cladocerans are found in abundance in less saline areas. The pattern of fluctuations of zooplankton runs parallel with phytoplankton.

Common genera of flagellates are *Euglena, Dynobryon, Ceratium, Phacus, Peridinium, Noctiluca* and *Trachelomonas*. Of the protozoa common genera are *Dijtugia, Bursaria, Vorticella*, etc. *Brachionus, Keratella, Trichocerca, Filinia, Hexartha, Notholca* and *Ploesoma* are common genera. Of the copepods, common genera are *Diaptomus, Cyclops, Paracalamus, Microsetella*, etc. *Bosmina, Bosminopsis, Daphnia, Moina* and *Ceriodaphnia* are common genera.

Fish population of Hooghly-Matla Estuary

More than 150 species of fish occur in this region. These are more than 150 bheris in reclaimed and embanked land (3500 km^2). The fish seeds are mainly of mullets, perches, threadfins, catfishes, prawns, carps etc. Fish production in India in estuarine in about 7000 M.T. annually.

Maximum catch is formed of prawn species viz. Bagda Chingri (*Panaeus* sp.), Chapra Chingri (*Panaeus* sp.), Honye Chingri (*Metapenaeus* sp.), Chamme Chingri (*Metapenaeus* sp.), Golda Chingri (*Macrobrachium* sp.), Goda Chingri (*Palaemon* sp.) and Ghona Chingri (*Leander* sp.). Other species which are common, consist of Bhetki (*Lates* sp.), Parse (*Mugil* sp.), Bhangon (*Mugil* sp.), Nona Tengra (*Mystas* sp.), Gurjaoli (*Elentheronema* sp.), Chanda (*Scalophagas* sp.) etc. *Hilsa ilisha* is pretty common in the estuary besides Clupeids, Bombay duck (*Harpodon* sp.) etc. Ribbon fish (*Trichiurus* sp.).

Plant–animal relationship

There are specific interrelation between some plants and molluscs and crustacea. For instance, *Aesiminea brevicula* prefers to live on trees, on leaves and on branches, *Neritina depressa* prefers trunks and lower branches, *Martesia striata, Banksia edmondsoni* and *Teredo juttingae* prefer roots, trunks and submerged branches, Generally *Littorina* and *Neritina* are surface burrower. Above tidal level occur *Telescopium cer-*

ithidea, Pythia, Eilobium etc. Innumerable such examples can be cited on estuarine and mangrove tracts. Of the plant *Sonneretia apetala, S. acida, Avicennia* sp. and *Xylocarpus* sp. should be protected from felling.

Very little is known about Estuarine mammals and the ecology, but the effect of mud or sediments in water is very much perceptible. Some of them are rare. Their movement is guided by availability of food. Flesh of *Platanista gangetica* sp. is edible.

Problems

Calamities to the wetland sites have been brought by miscalculated and ignorant human activities. The swamps have been reclaimed and brought under agricultural crop; various sites have been poisoned by retting of jute fibres, use of pesticides for eradication of mosquitoes and for drainage.

Indiscriminate shooting of birds have been done by hunters all over the country which has diluted the population of game birds. Many water-birds have been regularly trapped in the villages especially during bedding season, besides illicit collection of thousands of eggs and fledgling to provide delicacies in the restaurants of the cities.

Unique aquatic sites like one in Tale valley in temperate hills of Arunachal Pradesh (near Zero) which are like *Sphagnum* bog of the West have been converted into cultivated land. Cattle grazing in the swamps have diluted the species and their individuals.

Plant and animal succession go parallel in many swamps. Some animals are manipulators of plant-succession processes. This chain has been disturbed. Turbidity in water has been detrimental to the growth of water plants, fresh and other aquatic animals. So the task to save the aquatic sites seems to be stupendous. □

Notes and news

Special production agency for scientific gadgets likely

The Union government proposes to set up a special agency to fabricate scientific gadgets for use in a broad spectrum of activities, including agriculture and defence.

Chairman of the Science Advisory Council to Prime Minister C. N. R. Rao said here that the agency would be part of a strategy to achieve rapid progress in the area of instrumentation. Infrastructure facilities were incomplete in several scientific organisations and industry due to the paucity of instruments.

The Council had constituted a task force under the leadership of G. Venkataraman of the Indira Gandhi Centre for Atomic Research at Kalpakkam near Madras to prepare a status report on the instrumentation industry and to make recommendations on improving the industry, he said.

The task force, in its report, had suggested a crash programme and a long-term strategy to develop the industry.

Under the crash programme, it had idenified some important instruments that should be manufactured immediately for applications in education, defence, medicine, environment and industry, C. N. R. Rao said.

It had recommended the creation of a special production agency on the lines of the Centre for Development of Telematics (C-DoT), with considerable flexibility and autonomy. "There could be separate wings to cater to the instrumentation requirements of the various sectors. However, there must be complete standardisation across the board"

Rao said the task force had said the agency should be given "sufficient guarantee" that its output would be lifted. The Union government must curb the import of models comparable with those available indigenously and provide adequate price support in addition to market assurance.

The task force said the Indian Institute of Science here would be a good choice to house the research and development (R and D) cell of the proposed agency.

The cell should carry out system design and ultimately ensure that a technology package was evolved.

It said the government should earmark at least one to two per cent of the anticipated plan expenditure on instruments and control systems for R and D every year.

In the long-term strategy, the task force suggested creation of a chain of hi-tech industries which would produce various items from components through sub-systems needed in sophisticated instruments. The government must also declare instrumentation as a "crucial area" for development and extend to it the special treatment given recently in the case of electronics.

Listing various factors inhibiting the growth of the instrumentation industry, the task force said instrument manufacture could be made a profitable venture through a bold and imaginative fiscal policy with incentives to the industry. The private sector must be allowed to meet some of the requirements of defence in the area of hi-tech instruments and sub-systems.

The report listed ways to develop human resources to make the suggested programme a success. It said facilities like the Indo-Swiss Training Centre (ISTC), Chandigarh, should be established for imparting training in areas like optical engineering and UHV technology.

Other measures suggested by the report included short-term courses for school and college teachers in instrument maintenance, training of personnel in the maintenance of hospital and medical instruments and regular training camps for small scale entrepreneurs who would form the "backbone" of the proposed thrust programme.

The task force also recommended the establishment of a special directorate to monitor the R and D, oversee the linkage of R and D with industry and assimilation and updating imported technology packages. The Government must also ensure continuous monitoring of the proposed strategy and make midcourse corrections when required.

'The broad objective should be to achieve strong capability in base technologies like precision engineering, fibre optics and sensor technology so that a wide range of instruments from computer controlled analytical instruments to complex, multi-technology defence systems (like those for thermal imaging) are availabe indigenously within, say, 10 years', it said.

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Economics Times

Need for a law of the atmosphere

A group of international scientists have called for immediate specific actions to reduce the threat of global warming of the atmosphere, which they believe will inevitably lead to faster rates of climatic change and greater exposure to flooding that ever experienced before in human history.

The scientists released a report on June 6 based on the findings of two international workshops held last year under the sponsorship of several funding agencies, including the United Nations Environment Programme, the Beijer Institute in Stockholm, the Enivronmental Defence Fund in New York and the Woods Hole Research Centre in Massachusetts.

The workshops, each involving scientists from between 10 and 15 industrialised and developing countries, examined how a predicted warming of the Earth's surface caused by the accumulation of certain gases in the atmosphere, the so-called "greenhouse effect", could affect the global environment over the next century. The scientists also explored near-term policy steps that should be taken to counter the effects of climate change.

According to M. Oppenheimer, a scientist with the Environmental Defence Fund, global temperatures have already increased by nearly one degree centigrade during the last century owing to increased atmospheric concentrations of gases such as carbondioxide, methane, nitrous oxide and more recently manmade chlorofluorocarbons, chemicals that have also been blamed for the depletion of the Earth's protective ozone layer.

According to a recent article in the scientific journal *Nature*, the 1980s have so far accounted for the five warmest years in the history of global measurements.

"And there are scientists who argue that the already emitted gases have built in between a half degree and a full degree centigrade of warming that will manifest itself over the next few decades no matter what we do", Oppenheimer said. "So from that perspective it is already too late to prevent global warming. We should have begun action some time ago".

According to the scientists each molecule of carbondioxide, produced by the burning of fossil fuels as well as natural processes, stays in the atmosphere for an average of about 100 years before being reabsorbed by plant life or other means. Chlorofluorocarbons, the manmade chemicals used in such things as aerosols, refrigeration and airconditioning, also stay in the atmosphere for about 100 years before disappearing.

The new study calls for immediate reductions in emissions of carbondioxide and chlorofluorocarbons as "two of the most powerful ways to slow down global warming".

For the reason, Oppenheimer said, the scientists are calling for the ratification and strengthening of the Montreal Protocol for protecting the stratospheric ozone layer and the acceleration of its implementation. The protocol is an international accord signed last year to reduce the use of chlorofluorocarbons by 50 per cent by 1999.

"We are also calling for the development of long-term energy strategies which encourage high-energy efficiency", Oppenheimer said, "Several authoritative studies suggest we could, with current technologies, cut our energy use in half. We must also intensify research and development in non-fossil-fuel alternatives.

Oppenheimer also called for measures to limit the growth of other greenhouse gases contributing to the greenhouse effect, such as methane, "For example, we should tap the methane from solid-waste landfills which now just goes up into the atmosphere", he said. "Methane from solid-waste landfills is a significant contributor to the growth of this greenhouse gas in the atmosphere".

Other near-term actions called for by the study include identification of areas vulnerable to sea-level rise, co-ordination of global monitoring activities and scientific research on the greenhouse gas issue at national and international levels and examination by international organisations of the need for an agreement on a law of the atmosphere as a "global commons" or the need to move towards a protocol along the lines of that developed for ozone.

The new study reports that the continued emission of greenhouse gases at today's levels, with no action taken to curtail the rate of emission, could lead to an increase in global temperature of 0.8 degrees centigrade per decade from the present to the middle of the next century.

This kind of global warming according to the report, "could accelerate the present sea-level rise possibly as much as 1.5 metres by the middle of the next century. The effects will include erosion of beaches and coastal margins, increased frequency and severity of flooding, damage to port facilities coastal structures and water management system".

The report said global warming over the next century could also decrease levels of precipitation in the semi-arid tropical regions of the world, thus worsening current critical problems such as the shortage of food, water and wood for fuel.

Many scientists argue, however, that the effects of the greenhouse gases on the atmosphere are overestimated and that the warmer temperature experienced during the last decade, for example could be due to other climate variations. — USIS □

The Hindu

Normal rain predicted

The Indian Meteorological Department (IMD) has predicted normal rainfall in north-west and peninsular India during the monsoon with a 10 per cent shift on either side. These are the two regions of the country where monsoon rainfall exhibits considerable inter-annual variations.

The peninsula includes Maharashtra, Gujarat, Madhya Pradesh, Telengana, north interior Karnataka, coastal Andhra Pradesh and coastal Karnataka and the north-west India region comprises Jammu and Kashmir, west Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, Delhi, Chandigarh and Rajasthan.

The IMD has used the same technique of statistical correlations —which it had used and made qualitative predictions last month of early onset of monsoon and above average total rainfall for the country as a whole for the year 1988 — for quantitative long-range forecasts monsoon rainfall over the two regions.

Two different models, the Multiple Regression Model (MRM) and the Auto Regressive Integrated Moving Averages (ARIMA) model, were used for computing these quantitative estimates. According to the former there is an 80% chance that the season's rainfall would be 111% of the normal over the Peninsula and 123% of the normal over the North-west. The latter predicts 103% and 95% rainfall in the two regions. From the long-range monsoon forecasts of the two models over the years, there is evidence to indicate that the ARIMA perform better than the MRM. Hence the IMD has attached more weightage to the forecasts of the ARIMA mode. *Probabilistic computation:* The MRM performs a purely probabilistic computation of the total rainfall based on the nature of the antecedent meteorological features in various parts of the world which have been found to have statistical associations with monsoon rain from its past history.

The ARIMA on the other hand, goes a step further and attempts a mix of deterministic and probabilistic techniques. Briefly stated it seeks to express the time series—a statistical technique which simulates obtaining data at regular intervals of time—of a meteorological variable as a combination of a part that is determined by past history and a random sequence of shocks or sharp variations which are imposed over and above.

The success of the ARIMA model depends to a large extent, therefore, on finding a suitable 'leading indicator'. A "leading indicator" is that variable—of the several identified antecedent factors—which modulates the behaviour of the time series.

V. Thapliyal of the Indian Institute of Tropical Meteorology (IITM), Pune, who has studied the ARIMA method extensively, has found that the pressure ridge along 75° E longitude at the 500 millibar level (about 5.8 km high) is the leading indicator. A favourable condition of this feature is that its mean position in April should be at about 16 latitude.

Among the 15 parameters identified for this year's computation this particular one has been found to be somewhat unfavourable. It was found to be anchored somewhere around 14.5 latitude. Though this is the leading controlling factor, this deviation is considered minor. □

The Hindu

Profile of the Guha Institute of Biochemistry

The Guha Institute of Biochemistry has been promoted by the ex-students and admirers of the late Bires Chandra Guha, the founding father of Biochemical Research and Education in India, aptly described as the 'Hopkins of India', as a fitting memorial to this outstanding scientist, teacher and revolutionary thinker, pioneer and patriot, whose wide intellactual spectrum and dynamism profoundly influenced scientific life and thought in this country for over a quarter of a century. The objects of this Memorial Institute as set out in detail in the Memorandum of Association, cover broadly all aspects of promotion and advancement of research, training and education in Biochemistry and allied sciences, nationally and internationally.

The Institute Office has been located in the residence of Guha, given away with his life's savings by him and his illustrious wife Phulrenu Guha, Member of Parliament for the advancement of Biochemistry and allied sciences. The Institute which is run by a Governing Body composed of eminent scientists of India is arranging to hold national/international Seminars and Workshops covering modern biochemistry, biotechnology and allied fields from time to time.

A Master Plan for the Institute on its own campus in the Salt Lake areas of Calcutta allotted by Govt. of West Bengal is being drawn up for phased implementation, depending upon the availability or resources. Capital and recurring grants for the purpose are being arranged from Central and State Government Departments concerned and donations from benevolent public/charitable trusts, other organisations and individuals are being invited. Ex-students and others interested in Biochemistry and in the objectives of the Institute are requested to join the Institute as members, paying an annual subscription of Rs. 100/- or 1,000/- for life membership. The first phase of development, hopefully expected to be implemented in about three years, may entail expenditure of over Rs. 10 crores for a period of 5 years including building, infra-structure facilities as well as scientific and administrative staffs. Donations are expected to qualify for exemption from Income Tax.

All communications/remittances may please be addressed to D. K. Chaudhuri, Member-Secretary, Guha Institute of Biochemistry, 55/5, Purnadas Road, Calcutta 700 029. ☐

Programme to bring native wildlife home

The biblical Book of Job offers the reader some of the most perceptive observations of wildlife made during antiquity. Job's descriptions of ostrich behaviour, wild-ass habitat, ibex birth and oryx antelope domestication are but a few of the great animal-love treasures to be found in this revered book of Scripture. Job, of course, was not alone in commenting upon the animals of ancient Israel. David, the psalmist who was to become king, enjoyed the beauty and variety of wildlife. And so he wrote "..... in wisdom hast thou made them all ! " David passed some of this appreciation on to his son, Solomon, who later wrote one of the most appealing verses of the Bible : "Deliver thyself, as a gazelle from the hand of the hunter and as a bird from the hand of the fowler".

Unfortunately, many of the birds, gazelles and other wild animals of Israel were not so successful in avoiding hunters or trappers. The introduction of modern firearms into the Middle-East during the 19th century was particularly devastating and several inhabiting the Holy Land since Noah's time were literally shot into extinction. When the modern State of Israel was proclaimed in 1948, the land was barren and wild animals of any type were extremely rare. Since then, however, an ambitious programme has revitalised the country. Very strict conservation laws, combined with active protection and restoration campaigns, have resulted in dramatic improvements. Today, Israel has more than 200 nature reserves, occupying 20% of the country's total land area. Wildlife is well protected, generally compatible with agriculture as well as human settlements. Nearly three dozen leopards are living free in Israel. The wolf population is about 500, ibex population almost 3,000 and the gazelles stand 10,000 strong. Israel also hosts populations of caracal, eagles, foxes, hyenas, jackals and many other species. Because these animals are not hunted, they have little fear of human beings. Thus, it is entirely possible to stand within 3 m of magnificent ibex as they roam their native habitats in the Judean Hills. Golden eagles have been nestling in Jerusalem for several years. When one considers that Israel (excluding the West Bank and Gaza Strip) is no larger than the State of New Jersey, these wildlife population figures are very impressive. Just imagine what would happen if 30 leopards were let loose around New Jersey ! Or even 500 wolves !

As a general policy, Israeli farmers are responsible for protecting their crops without destroying wildlife. So hunting, poisoning and trapping campaigns are prohibited. Instead, farmers are encouraged to build proper fances to keep gazelles out of their flocks of goats and sheep. When occasional problems arise, farmers call experts from the Israel Nature Reserves Authority, who instruct them in techniques of protecting agriculture without harming wildlife. This strong protectionist attitude is not enough. To compensate for the tragic losses of former centuries, Israel is conducting a Hai-Bar (literally wildlife) programme—a major effort to restore the animals of the Bible to the Land of the Bible. To do this, Israeli wildlife biologists search the world for their country's wild animals—wild ostriches were located in Ethiopia, roe deer were found in a private Dutch shooting reserve, addax antelope were discovered in a Chicago zoo. These animals are then acquired and flown back to Israel, where they are brought to specially equipped nature reserves. Nearly all of Hai-Bar's animals have come from private reserves, safari parks and zoos and nearly all of them are quite tame. If released into Nature, they would be quickly killed off by predators or the harsh environment. At Hai-Bar, they gradually learn to thrive on natural foods; they are encouraged to organise themselves into natural herd structures, are taught to sharpen their senses and be aware of lurking predators. A Hai-Bar antelope finally learns to ignore humans wandering about their habitat, but if wolves are detected, the herd gathers for mutual protection and prepares for a vigorous defense. This education process takes many years of very hard and technical work. For example, Hai-Bar acquired its first Asiatic wild ass in 1968 from the Copenhagen zoo. It took 14 years of work until these docile and insensitive creatures became tough enough to be released into the desert. At the end of their education in 1982, the first herd released into the Central Negev Desert proved alert and hardy enough to survive in an extremely hostile environment—120°F temperature, precious little water and the company of hungry leopards and wolves. Yet this is the wild ass's natural habitat and properly re-adapted these animals have flourished in their ancestral range. And now, each summer, new hards of wild ass are "seeded" into the desert. Today, wildlife enthusiast visiting the Negev can see these rugged and unbridled equines running freely in a desert. After watching them for a while, it is easy to understand why the prophets considered them symbols of freedom. Surely, they are different animals than their cousins locked in zoo paddocks.

Many other species are also undergoing the Hai-Bar restoration process. Some are returned to Israel in dramatic rescue operations. The biblical fallow dear, now browsing the oak forests atop Mount Carmel, were airlifted out of Iran in December 1978 after the Shah had abdicated and anarchy ruled the streets of Teheran. The spectacular white oryx antelope—the unicorn of the King James version of the Bible—came from the personal stock of the late Saudi monarch Faisal via third party !

As wild animals are being restored to their natural habitats, conservationists are observing many new benefits. Israeli farmers now appreciate having falcons, owls and other birds of prey neating nearby because they keep rodent populations in check naturally without restoring to cruel poisons. Ecologists appreciate the improvements, because it means all the other mechanisms of Nature are in harmony. No large populations of leopard or wolves can exist without large populations of prey herbivore animals. These cannot exist without unpolluted water, adequate habitat and vegetation. The entire infrastructure must be in place to support fully dynamic wild populations. The general public too appreciates the improvement. More and more Israelis are visiting nature reserves today—partly because of the sheer delight of viewing gazelles bound over grassy meadows and ibex leap upon craggy mountains. More significantly, however, Israelis have come to appreciate the wholesome values of Nature and the vital need to re-integrate the human community into a better relationship with Nature and her wild children. Indeed, this is a very old lesson. Consider : "I said from my heart ..... that mean also are animals. What happens to man, also happens to animals. As one dies, so dies the other. They share one breath, and man has no pre-eminence above an animal" (Ecclesiastes 3 : 18, 19). □

News from Israel

Taming the wild south

Thirty-seven countries met at Wellington in New Zealand this week, to set up a legal framework for mining in Antarctica. New Zealand, whose land claim in Antarctica is free of ice and can be exploited by miners using existing technology, has abandoned attempts to declare the continent a park. It says that a legal framework is necessary before mining begins to ensure that future excavation work is "environmentally acceptable".

The Antarctic Treaty of 1959, the only legal regime covering the continent, provides neither for environmental protection nor for private rights. Prospective miners, including the governments of the United States, Britain, West Germany and Japan, oppose any regulation. The Antarctic Southern Coalition, a group of environmentalists, says that the absence of legal protection for mining companies is now the biggest barrier to mineral exploitation of Antarctica. It says that any mineral regime will open up the continent to devastation. □

New Scientist

Burning to germinate

Forest fires in Uganda are helping the Savanna tree, *Acacia sieberiana*, to survive. The tree survives in the Queen Elizabeth National Park, Uganda, by producing large numbers of seeds. Most of these fail to germinate, if they simply fall to the ground because up to 96% are infested with larvae of bruchid beetles.

In the past, browsing animals ate the pods. As the seeds passed through an animal's gut, the seed-coats were softened and this killed the bruchid larvae. However, poachers have killed a large number of browsing animals in the area resulting in fewer Savanna trees. This has also led to much more intense forest fires.

E. N. Sabiiti and R. W. Wein of the University of New Brunswick have found that 65% of Savanna tree seeds taken from burned areas germinated in the laboratory compared with 10% from unburned areas. The difference between the two samples is due to the effect of heat on the seeds from the burned areas and not due to the changes in soil conditions caused by the fires. The heat cracks the seed-coats and kills the bruchid larvae. This produces much the same result as a passage through an animal's gut. So the fires, which are almost all started by humans, are to some extent compensating for the lack of browsing animals. □

New Scientist

Letters to the editor

Effect of high hydrostatic pressure on cell cycle

Hydrostatic pressure markedly influence rates of reaction[1]. Any rate process is further influenced by the viscosity of the medium. The cell size is directly related to protoplasmic viscosity[2]. The rate of flow, used as a criterion for the activity of protoplasm streaming, depends on the viscosity of the protoplasm. For a chemically complex substances like protoplasm, the dependence of the viscosity on the pressure is extremely sharp. It is mainly due to the deformation of molecules. The observed pressure variation of the coefficients of viscosity η can be written in the form

$$\frac{\eta_m}{\eta} = \exp\left(-\frac{\Delta H_0 + p\Delta V}{RT}\right), \qquad (1)$$

where η_m is the maximum limiting viscosity ($\eta_m \gg \eta$), ΔH_0 is the free activation energy for viscous flow (cell characteristic), ΔV the increase in volume, T the absolute temperature and R is the gas constant. As the pressure increases, relative viscosity decreases. From the theory of rate processes[3], one gets

$$\eta_m = \frac{Nh}{V}\exp\left(\frac{\Delta H'_0 + p\Delta V'}{RT}\right) \qquad (2)$$

N is the Avogadro number, h the Planck's constant and V the molal volume of flowing unit.

From equations (1) and (2), one gets

$$\eta = \frac{Nh}{V}\exp\left(\frac{\Delta \overset{*}{H}_0 + p\Delta \overset{*}{V}}{RT}\right), \qquad (3)$$

where $\Delta \overset{*}{H}_0 = \Delta H_0 + \Delta H'_0$, $\Delta \overset{*}{V} = \Delta V + \Delta V'$, $\Delta \overset{*}{H}_0$ and $\Delta \overset{*}{V}$ are respectively the free-energy increase and volume increase in going from the folded, globular form to the activated state for flow of the fibrous gel state.

The above equation shows the dependence of pressure on the coefficient of viscosity. The pressure and temperature are interelated in the sol-gel status of a protoplasmic gel, i.e. as the pressure is increased the temperature must be raised to maintain the prepressurized degree of gelation. A gel has some rigidity and elasticity. The viscosity of gel material is intimately connected with the shear modulus and hence with the modulus of elasticity. A linear relationship can be found between rigidity and elasticity for many materials but this is not necessarily true for protoplasmic gels as the viscosity has some relationship with the elastic properties of protoplasmic gels. (The structural strength and other physical properties of such gels may vary from cell to cell but, in general, they all have the same general characteristics). The rigidity of the cell as a whole increases before the onset of cytokinesis[4] but since the rigidity of the cortical plasmagel is reduced by pressure[5], the cleavage furrow will cease to grow inward or will even recede, depending on the degree of solation and thus the process of cell division may be retarded, prevented or even reversed. (The cortical plasmagel becomes firmer in consistency just before the furrow appears and remains so during its inward growth. The gelation of the protoplasm is an important factor to produce the furrow[5]). Cytoplasmic cleavage is found to be more susceptible to inhibition by pressure[6]. Under the influence of pressure, viscosity and rigidity thus play predominating factors limiting the process of cell division.

Pressure has been shown to retard, prevent, or even reverse the furrowing of various egg cells according to the amount of the pressure and the stage of division[7]. If the cells that are normally spherical (for example, *Arbacia* eggs) are pressurized during the process of division when the cells have become elongated, return to the spherical condition again under pressure[8]. Growth of some marine bacteria without cell division has been reported under increased pressure[8]. Under 200-atm pressure at room temperature, the spindle appears to dissolve completely and the chromosome movement is profoundly retarded. The relative viscosity of *Amoeba* is found to decrease with hydrostatic pressure[9]. The relative viscosity of cytoplasm in the ciliate *Blepharisma* at 200 atm was measured[10] and a significant decrease was noted. If the viscosity drops below a certain critical value, cell division ceases. Certain upper and lower limits to the pressure and temperature effects are noted[6], above or below the limits, the binding components of the gel are destroyed (the limitations, however, depend on cell type) and these conditions prevent any reversible solation or gelation.

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Pressure solution structures in Bhima carbonate rocks (Late Precambrian), Karnataka

The Bhima basin in northern part of Karnataka is irregular in outline. It extends between long 76° 15' to 77° 30' and lat. 16° 15' to 17° 35' and covering an area of 4,200 sq km. The rock sequence is represented by almost unmetamorphosed late Precambrian sedimentary rocks, spread over parts of Bijapur and Gulbarga districts. The sequence rests on the basement gneisses and the Dharwars with a pronounced unconformity and are overlain by the Deccan traps. The Bhima sequence consists of sandstones in the lower part, limestones and shales in the middle and upper parts. This rock sequence as a whole does not appear to have any contact with the Proterozoic Kaladgi and Badami sediments which lie close to the western part of the basin.

The stratigraphy of the Bhima group was first described by Bruce Foote[1] who named it as the Bhima Series. He correlated them on the broad lithological aspects with that of Kurnool and divided them into lower and upper series. Later Mahadevan[2] proposed a three-fold classification based on sedimentation and lithology. Janardhana Rao *et al*[3]. have reclassified this series and identified the five formations representing a sequence of strata whose lithology changes in regular order from base to top, but is persistent laterally. They redesignated the Bhima Series as Bhima Group.

The chief lithological units of this group are the conglomeritic quartzites, shales and limestones. The outcrops of carbonates spread over 2000 sq km[4] of the total area of 4,200 sq km. The rest of the area is covered by shales and sandstones.

The carbonates have been influenced by the pressure solution phenomenon, resulting in the development of both macro and micro scale stylolites. The occurrence of stylolites is significant, interesting and quite important in understanding the sedimentologic and diagnetic aspects. The stylolites in the Bhima group were first reported by Mathur and Jayaprakash[5-6] from the middle Bhima carbonates. However, the present account is the first detailed report of these structures from the Bhima carbonates.

Recently, the authors in the course of a detailed investigation in parts of Bhima basin have come across stylolites of different types and forms with variable amplitude and wave length. These stylolites are occurring parallel to the bedding and fracture planes, although vertical stylolites are not uncommon. The abundance of macro- and micro-stylolites in Bhima carbonate rocks can be broadly classified into horizontal stylolites, which are parallel to the bedding planes, the vertical stylolites roughly perpendicular to the bedding, having simple and suture types are found to have developed in the fracture planes. These structures reflect the probable tectonic influence over the area.

The stylolites have been classified by Park and Schot[7] based on geometrical aspects into six types. They are, (i) Simple wave-like type, (ii) Suture type, (iii) Up-peak (rectangular) type, (iv) Down-peak (rectangular) type, (v) Sharp-peak type and (vi) Seismogram type.

The authors have studied in detail the stylolites of Bhima sediments which are correlated with the patterns of Park and Schot[7]. It has been found that there are a few more stylolite patterns not reported earlier. These structures are abundantly developed in the dolomitic limestones, although they are generally developed in all the carbonate rocks. They are of both macroscopic and microscopic scales. Based on the geometric aspects, involving wavelength, amplitude and orientation with reference to the bedding they are described and classified as follows (Fig. 1):

(1) Suture type, Suture-ridge type,
(2) Simple wavy/undulatory type,
(3) Up Sharp-peak type,
(4) Down Sharp-peak type.

The development of both horizontal and vertical types of structures, the variability of new patterns, besides a thin film of clay capping on both sides of the structures supports the idea of solution pressure theory under the influence of tectonism during the diagenesis of these sediments. The occurrence of fractures—faults and the development of cleavages are probably due to tectonic activity in the area.

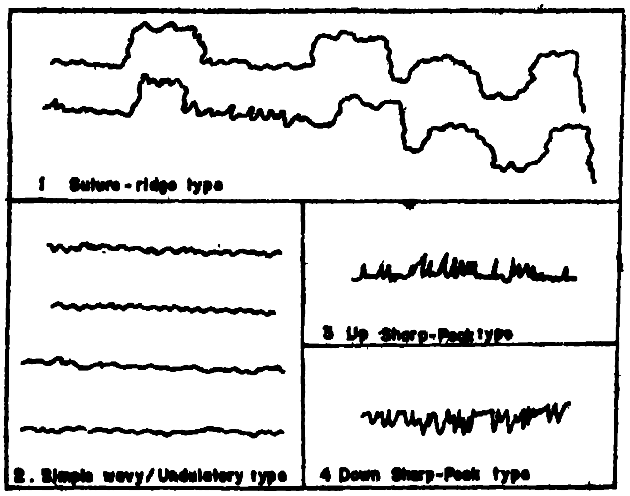

Fig. 1. Pressure solution structures in Carbonate rocks

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Inherent status of biochemical constituents and adventitious rooting in *Pyrus pyrifolia* Burm.

In addition to the natural and synthetic auxins, there are some other biochemical constituents which are directly or indirectly associated with rhizogenesis in fruit plants. However, variable correlations have been established between endogenous plant metabolites and rooting response of cuttings[1]. The present investigation was undertaken in cv. Sandpear (*Pyrus pyrifolia* Burm.) to study the relationship between inherent biochemical constituents and adventitious rooting under the influence of indole-butyric acid (IBA) treatments.

Hardwood cuttings of pear, 18-20 cm long and 0.8-1.0 cm diam were prepared during December, 1984 and were treated with 0, 50, 100 and 200 ppm IBA (24 h soaking); 500, 1000, 1500, 2000 ppm IBA (30 sec quick-dip) and Seradix B_3 (powder form of IBA). In all, there were nine treatments with three replications. In each treatment, there were 50 cuttings. After growth-regulator treatments, the cuttings were stored in moist sand at a temperature between 6° and 10°C for 30 days for callus formation. For the estimation of carbohydrates, total phenols and total nitrogen in the cuttings standard methods were followed[2]. These constituents were determined from the fresh as well as after 30 days of storage of cuttings. The cuttings were transplanted in the field during January, 1985. Correlation coefficients (r) between rooting and different characters were worked out.

The initial biochemical constituents in the fresh untreated cuttings were as follows : Starch (28.2 mg/g), total phenols 2.2 mg/g), total nitrogen (10.2 mg/g) and C:N ratio (4.0). The data on rooting success and its relationship with biochemical constituents after 30 days of callusing are presented in Table 1.

TABLE 1 : Changes in biochemical constituents in pear cuttings (Cv. Sandpear) during callusing

Treatments	Rooting success (%)	Starch (mg/g)	Total sugars (mg/g)	Total Nitrogen (mg/g)	C/N ratio	Total phenols (mg/g)
IBA (ppm)						
0	20.1	24.2	10.6	14.8	2.3	1.5
50	31.0	20.3	18.2	13.4	2.8	2.0
100	41.1	19.3	20.3	11.8	3.3	2.2
200	31.5	19.7	17.0	12.8	2.8	2.2
500	27.0	18.3	17.6	14.1	2.5	1.9
1000	24.0	18.8	16.9	15.1	2.3	1.9
1500	33.9	19.6	18.0	12.9	2.9	2.1
2000	36.0	20.2	17.2	12.3	3.0	2.1
Seradix-B_3	27.4	18.0	16.4	12.6	2.7	1.9

$r_{1,2} = -0.29$ $r_{1,3} = +0.79$ $r_{1,4} = -0.83$

$r_{1,5} = +0.97$ $r_{1,6} = -0.86$

Among the 24 hr soaking treatments, 100 ppm IBA gave the maximum rooting success of 41.1% and it was recorded to be minimum 20.1% in untreated cuttings. In earlier studies[3], 100 ppm IBA gave 30.0% rooting success in pear cuttings. In case of quick-dip treatments, 2000 ppm IBA produced 36.0% rooting which was significantly better than the success obtained with 500 and 1000 ppm concentration. Seradix B_3 (powder form of IBA) was not superior over solution form of IBA in inducing roots in cuttings. Previous studies reveal that 10000 ppm IBA in powder form or 5000 ppm solution with quick-dip method gave same rooting success in pear cuttings[4] of cv. Williams. In later studies, very little rooting was obtained in different pear cultivars with 500 and 1000 ppm IBA application[5]. This variation in dose response may be attributed to the differences in variety, time of preparation and physiological status of cuttings.

Maximum rooting success of 41.1% was correlated with the higher total sugars; C/N ratio and total phenols. The untreated control cuttings with the lowest rooting success of 20.1% percent were correlated with maximum starch and lowest total sugars, total nitrogen, C/N ratio and total phenols. It is also clear that except total nitrogen ($r_{1,4} = -0.83$) and starch ($r_{1,2} = -0.29$), all other biochemical constituents showed positive correlation with the rooting of cuttings. The relationship between C/N ratio and total phenols with the rooting of stem cuttings in different plant species has been established earlier[3, 6]. It has been reported that high C/N ratio favoured the rhizogenesis. The increased level of phenolics might have augmented the endogenous level of IAA due to its synergestic effect which increased rooting of cuttings in a wide range of horticultural plants[7]. However, a casual relationship between the decreasing level of starch and total nitrogen with the increasing intensity of rhizogenesis could not be established. Similar observations were noted in case of peach x almond hybrid cv. Sloh[8].

It appears that solution form and 24 hr soaking treatments of IBA were superior to its 30 sec quick dip and powder form in inducing roots in pear cuttings. IBA application did influence the metabolic events. The rhizogenesis was having a positive correlation with total sugars, C/N ratio and total phenols, while total nitrogen and starch were negatively correlated with it.

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Senescence of detached fern leaves : effect of light, hormones and protein synthesis inhibitors

Senescence in detached leaves has been extensively investigated in higher plants[1, 2]. Recently, some preliminary data on the characteristics of leaf senescence of fern, a lower group of plants, have been published from our laboratory[3]. The present work aims at examining the responses of excised fern leaves to light, different types of hormones and the inhibitors of nucleic acids and protein synthesis. The differential behaviour of fern leaves during senescence to these agents is analysed.

Fully expanded fern (*Nehphrolepis exaltata* Schott.) leaves collected from a fern-house were thoroughly washed with distilled water before using them for experiments. Six leaflets were floated (dorsal side up) in each petriplate containing 20 ml of distilled water or different chemicals. Petriplates were kept in continuous dark or continuous white light (70 W m^{-2}) at 27°C in a temperature-controlled culture room. Kinetin, GA_3 (Gibberellic acid) and IBA (Indole butyric acid) were used at the concentration of 50 µM each. Cycloheximide, Chloramphenicol and Actinomycin-D were used in 200 µg ml^{-1}, 200 µg ml^{-1} and 10 µg ml^{-1} concs, respectively. The pigments were extracted in 80% chilled acetone. The total chlorophyll was estimated by the procedure as described by Arnon[4]. The mean values given in figures are based on 4-8 independent parallel experiments. Estimates of standard error of mean are of the order of 2-6%.

Light (12hr) does not show any significant effect on fern leaf senescence as characterised by loss of chlorophyll (Fig. 1) and total leaf protein (Fig. 2). This is in contrast to photoinduced delay of senescence in the leaves of higher plants, where the effect of light at this intensity is attributed to the action of phytochrome[5]. This finding, however, does not exclude the possibility of participation of phytochrome in delaying the senescence of fern leaves. A significant retardation of chlorophyll loss by red light pulse and inhibition of red light response by far-red light pulses suggests involvement of phytochrome (unpublished data). Since fern is a shade-loving plant, it is possible that light, even at a relatively low intensity, could oxidise the pigments. Therefore, the level of chlorophyll observed during senescence may be a balance between photoinduced oxidation of chlorophyll loss and phytochrome induced protection of pigments. The loss of pigments in light may disorganise pigment-protein complex. This could lead to a decline in the protein content even in light (Fig. 2).

Ineffectiveness of GA_3 and stimulating action of IBA on chlorophyll loss (Fig. 1) of fern leaflets are in contrast to the retarding action of

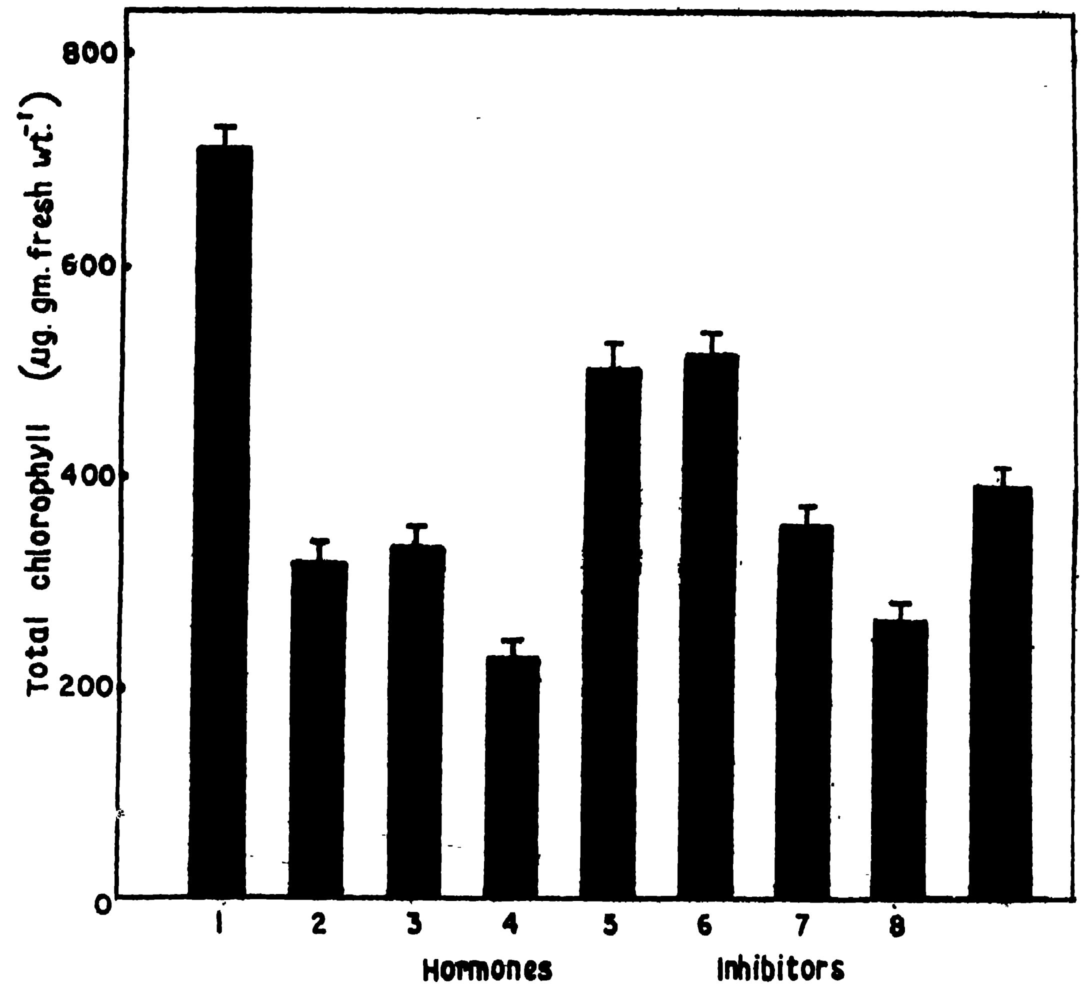

Fig. 1. Changes in the level of total chlorophyll of fern leaflets on treatment with phytohormones and protein synthesis inhibitors:
(1) non-senescing fern leaflets at the start of the experiments; (2) 12 d continuous darkness with water; (3) 12 d continuous darkness with GA_3; (4) 12 d continuous darkness with IBA; (5) 12 d continuous darkness with kinetin; (6) 12 d continuous darkness with cycloheximide; (7) 12 d continuous darkness with actinomycin-D; (8) 12 d continuous darkness with chloramphenicol; (9) 12 d continuous light with water.

these hormones on leaf senescence of several higher plants[1]. However, senescence retarding effect of kinetin both on chlorophyll and protein (Figs. 1 and 2) in fern leaflets may suggest a generalisation that cytokinins are the universal retardants of leaf senescence, since the hormone has already been shown to retard leaf senescence in higher plants[5].

The retardation of chlorophyll loss by cycloheximide suggests participation of proteins synthesized on 80S ribosomes on fern leaf senescence. On the other hand, chloramphenicol, which inhibits protein synthesis on 70S ribosomes of chloroplasts does not show any effect on chlorophyll loss (Fig. 1). Similar results on non-participation of organelle ribsomes regulating leaf senescence has been observed in higher plants[6]. On the other hand, Actinomycin-D, which normally does not show any effect on leaf senescence of higher plants, exhibits a significant retardation of chlorophyll loss in fern leaves. Actinomycin-D is an inhibitor of DNA-directed RNA systhesis. Senescence-retarding effect of the inhibitor suggests synthesis of senescence-related RNAs in fern leaves.

Senescence is normally investigated with fully mature leaves. It is suggested that the m-RNA for senescence induction is synthesized

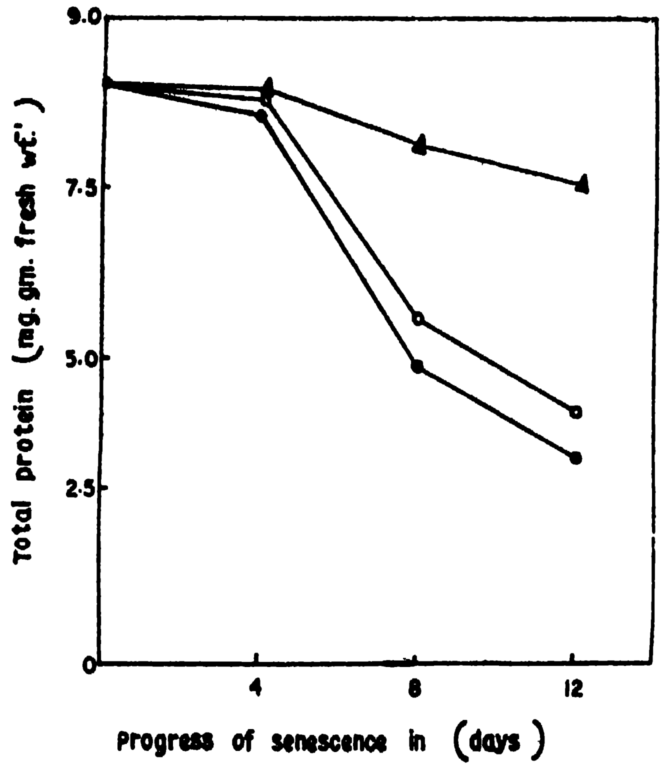

Fig. 2. Changes in the content of total protein of fern leaflets kept in continuous dark (●—●), dark plus kinetin (▲—▲) and continuous light (O—O)

at some sequence of leaf development, much before the complete development and leaf maturity in higher plants[7]. The m-RNA obviously is long-lived and exists in fully mature leaves before the induction of senescence[7]. However, the retardation of senescence by Actinomycin-D in fern leaves may suggest that synthesis of m-RNA for senescence induction occurs in mature leaves approaching the phase of senescence (Fig. 1).

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Leaf area determination in mulberry

Leaves are the main assimilatory organs, chiefly conserned with photosynthesis and the leaf area a reliable index for determining the overall metabolic efficiency of a plant in terms of dry matter accumulation, carbohydrate metabolism, yield and quality of the crop[7].

The leaves of mulberry (*Morus* Linn.) form the only source of food material for rearing silkworms to produce silk. A wide morphological leaf variation (heterophylly) prevails in this genus with leaves varying in shape from entire to variously lobed in different species and varieties. It is, therefore, imperative to develop rapid, accurate and non-destructive estimates of leaf area for this plant of high commercial value. Several methods[1-4] have been devised to determine the leaf area of various crops including mulberry[5,6], but the most common method in the majority of crops is by the mathematical regression formula using easily measured leaf parameters. The present study deals with the development of simple and reliable methods of computing leaf area in both lobed and unlobed varieties of Mulberry.

Twentyfive leaves from a lobed and an unlobed variety from each of the three *Morus* species (Tables 1 and 2) were taken and the leaf area was estimated by adopting various techniques, viz. plotting the leaves on centimeter graph paper and counting the squares (actual leaf area), calculating from the product of length and breadth of leaves, dry matter area basis of individual leaf and by using a constant factor after multiplying it to the product of the length and breadth. The constant factor was estimated by dividing the sum of actual area of all the leaves by the sum of products of length and breadth of these leaves for each variety. Making use of least square analysis, the constants were calculated for regression equations which were fitted to determine the relationship between the actual area (graphical method) and dry matter, leaf length, leaf breadth and length and breadth. Correlation coefficients between the actual leaf area and the area computated by different techniques were estimated (Tables 1 and 2).

The R^2 values estimated for the unlobed varieties, viz. Limoncina, Obawase and Goshoerami, representing all the three species of mulberry, revealed that the leaf area calculated by

TABLE 1 : Correlation of leaf areas estimated by different methods with actual leaf areas in unlobed varieties of three species of Mulberry

Method of estimation	Formula	r Value	R^2 (%)
Morus alba var. Limoncina			
L and B without factor	A = L x B	0.8640^{**}	74.64
L and B with factor	A = L x B x 0.7370	0.8641^{**}	74.66
Area on dry matter basis	A = 26.1791 + 74.3377 D	0.7663^{**}	58.72
Regression with L	A = –7.0418 + 7.5163 L	0.6667^{**}	44.44
Regression with B	A = –24.5397 + 10.9804 B	0.7174^{**}	51.46
Regression with L and B	A = –35.3007 + 3.5889 L + 7.7806 B	0.8548^{**}	73.06
Morus bombycis var. Obawase			
L and B without factor	A = L x B	0.5809^{**}	33.73
L and B with factor	A = L x B x 0.7438	0.9666^{**}	93.43
Area on dry matter basis	A = 15.2699 + 100.5849 D	0.8442^{**}	71.26
Regression with L	A = –64.2073 + 13.1260 L	0.9058^{**}	82.04
Regression with B	A = –54.1586 + 14.1761 B	0.9145^{**}	83.63
Regression with L and B	A = –73.0490 + 6.8714 L + 8.4065 B	0.9660^{**}	93.31
Morus multicaulis var. Goshoerami			
L and B without factor	A = L x B	0.9885^{**}	97.71
L and B with factor	A = L x B x 0.6827	0.9920^{**}	98.40
Area on dry matter basis	A = –49.4240 + 113.4476 D	0.9015^{**}	81.27
Regression with L	A = –218.0713 + 22.1571 L	0.9566^{**}	91.50
Regression with B	A = –237.8723 + 29.0753 B	0.9583^{**}	91.83
Regression with L and B	A = –246.4739 + 7.6028 L + 19.9821 B	0.9865^{**}	97.31

A = Actual leaf area (cm^2), L = Leaf length (cm), B = Leaf breadth (cm), D = Dry matter value of leaf (g), ** : significant at 1% level

TABLE 2 : Correlation of leaf areas estimated by different methods with actual leaf area in lobed varieties of three species of Mulberry

Method of estimation	Formula	r Value	R^2 (%)
Morus alba var. Ichinose			
L and B without factor	A = L x B	0.9461^{**}	89.51
L and B with factor	A = L x B x 0.6506	0.9561^{**}	91.41
Area on dry matter basis	A = –8.9589 + 95.6474 D	0.9185^{**}	84.36
Regression with L	A = –76.1460 + 12.8138 L	0.8738^{**}	76.35
Regression with B	A = –83.9263 + 4.9766 L + 10.6332 B	0.9695^{**}	93.99
Morus bombycis var. Shimanouchi			
L and B without factor	A = L x B	0.3122^{NS}	9.74
L and B with factor	A = L x B x 0.7272	0.9266^{**}	85.85
Area on dry matter basis	A = 58.0649 + 6.1551 D	0.9463^{**}	89.54
Regression with L.	A = –3.4370 + 6.6580 L	0.8510^{**}	72.42
Regression with B	A = –43.6846 + 12.1738 B	0.9420^{**}	88.73
Regression with L and B	A = –44.5686 + 3.1242 L + 8.7421 B	0.9486^{**}	89.98
Morus multicaulis var. Rokokuyaso			
L and B without factor	A = L x B	0.3342^{NS}	11.16
L and B with factor	A = L x B x 0.6556	0.8002^{**}	64.03
Area on dry matter basis	A = 62.5774 + 8.4245 D	0.7591^{**}	57.62
Regression with L	A = –1.8560 + 6.5257 L	0.8209^{**}	67.38
Regression with B	A = 43.4721 + 2.7254 B	0.8939^{**}	79.90
Regression with L and B	A = –13.6721 + 1.2017 L + 7.2509 B	0.9171^{**}	84.10

NS = Not significant, For symbols A, L, B, D and ** refer to footnote on Table 1 the method of using constant factor was the efficient one as compared to other methods of estimation, as is judged from R^2 values of these varieties; 74.64%, 93.43% and 98.40% respectively (Table 1). It is, therefore, evident that the leaf area of these unlobed varieties could be determined by simply multiplying the product of leaf length and leaf breadth with the constant factors of 0.7370, 0.7438 and 0.6827 respectively. Interestingly, in lobed varieties, viz. Ichinose, Shimanouchi and Rokokuyaso, representing all the three species of *Morus* Linn., viz. *M. alba* Linn., *M. bombycis* Koid. and *M. multicaulis* Poir., the multiple regression equation using both leaf length and leaf breadth gave very accurate estimates of leaf area as compared to other methods of estimation (Table 2). The R^2 values of these varieties estimated are 93.99%, 89.98% and 84.10% respectively.

Kasiviswanathan *et al.*[5], while estimating the leaf area of three mulberry varieties, viz. Mysore local, Kanva-2 and Kosen belonging to two species of mulberry (*M. alba* Linn. and *M. multicaulis* Poir.), recommended the method of multiplying constant factor to the product of length and breadth of leaves irrespective of the extent of lobation present. But this hypothesis in the light of the present study conducted exclusively on lobed and unlobed varieties of mulberry respectively does not hold true. The method of multiplying constant factor to the product of length and breadth in only unlobed varieties, viz. Limoncina, Obawase and Goshoerami, and the method of multiple regression equation using both length and breadth in only lobed varieties, viz. Ichinose, Shimanouchi and Rokokuyaso would be valid, as compared to other methods of estimation and can easily be applied in both destructive and non-destructive methods of growth analysis. Moreover, these methods could be adopted conveniently due to the main advantage of their simplicity in operation, as compared to the rating method in mulberry[6] which though reasonably accurate and non-destructive tends to be complicated and laborious when large samples have to be handled.

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Effect of different levels of basal and foliar application of nitrogen on fruit yield of Bhindi (*Abelmoschus esculentus* L.)

Bhindi, an important vegetable crop, is widely grown throughout the sub-tropical regions of the world. Agronomic manipulations specially nitrogen is necessary for better growth and fruiting of the crops, but the information on the response of nitrogen to Bhindi under agro-climatic conditions of Vindhya region of Madhya Pradesh is lacking in literature. Hence, an attempt was made in this study to determine the effect of nitrogen as basal and foliar application on yield of Bhindi.

Four levels of nitrogen viz. 0, 40, 60 and 80 kg/ha as basal and foliar spray also were tested in randomized block design with three replications at an experimental area of Department of Horticulture, College of Agriculture, Rewa (M. P.). Eighty kg P_2O_5 and 60 kg K_2O /ha was applied uniformly, whereas nitrogen was given as per treatment. The experiment was conducted in the plot size of 4 m x 2.5 m. The data was recorded on plant height, leaves/plant, fruit length and girth, fruit yield/plant and per hectare. The statistical analysis was carried out according to method described by Chandel[1].

The various parameters as influenced by basal and foliar application of nitrogen are presented in Table 1. Plant height, leaves/plant, fruit length and girth were significantly influenced by the use of nitrogen. Significant increase in fruit yield per plant was recorded over control due to both basal and foliar application of nitrogen. But, on an average, the yield/plant was higher in basal than foliar application of nitrogen.

TABLE 1: Effect of basal and foliar application of nitrogen on growth and yield of Bhindi

Treatment	Plant height (cm)	No. of leaves	Fruit length (cm)	Fruit girth (cm)	Fruit yield/ plant (kg)
Basal application of Nitrogen (kg/ha)					
0	65.7	13.08	15.06	1.75	0.49
40	81.1	13.98	15.64	1.76	0.53
60	82.5	14.26	16.11	1.96	0.63
80	93.1	15.18	16.12	1.84	0.72
C. D. 5%	7.2	1.04	0.306	0.042	0.06
Foliar application of Nitrogen (kg/ha)					
0	74.4	12.36	15.04	1.74	0.49
40	78.7	13.86	15.70	1.81	0.55
60	83.9	14.70	16.05	1.86	0.63
80	85.9	15.55	16.16	1.90	0.70
C. D. 5%	7.2	1.04	0.306	0.042	0.06

The average yield of Bhindi was 137.5 q/ha (Table 2). Basal application of nitrogen revealed that highest yield of 163.20 q/ha was recorded with 80 kg N/ha, followed by 60 kg N/ha (150.16 q/ha) and 40 kg N/ha (123.35 q/ha). The control registered the lowest yield of 113.35 q/ha. Similarly, the results of foliar spray of nitrogen indicated that 80 kg N/ha had the maximum yield of 159.14 q/ha followed by 60 and 40 kg N/ha. The combined effect of basal and foliar spray of nitrogen revealed that 80 kg N basal + 80 kg N foliar spray has given maximum yield followed by 80 kg N basal + 60 kg N foliar and 60 kg N basal + 80 kg N foliar which were 114, 110 and 103 percent higher than control. These results are in confirmity with the findings of Rathore and Singh[2] in Bhindi, Zauddia[3] in tomato, Prasad and Subramaniam[4] in Chilli and Tayde *et al*[5]. on cabbage. Therefore, it is suggested that 80 kg N as basal and foliar both may be applied in rainy-season Bhindi for maximum productions.

TABLE 2: Fruit yield (q/ha) of Bhindi as influenced by combined effect of basal and foliar application of nitrogen

Foliar spray / Basal	0 kg N/ha	40 kg N/ha	60 kg N/ha	80 kg N/ha	Mean
0 kg N/ha	89.53	112.13	125.53	126.23	113.35
40 kg N/ha	113.53	120.26	122.66	136.96	123.35
60 kg N/ha	96.56	147.23	174.63	182.23	150.16
80 kg N/ha	116.16	156.63	188.88	191.16	163.20
Mean	103.94	134.06	152.92	159.14	137.5

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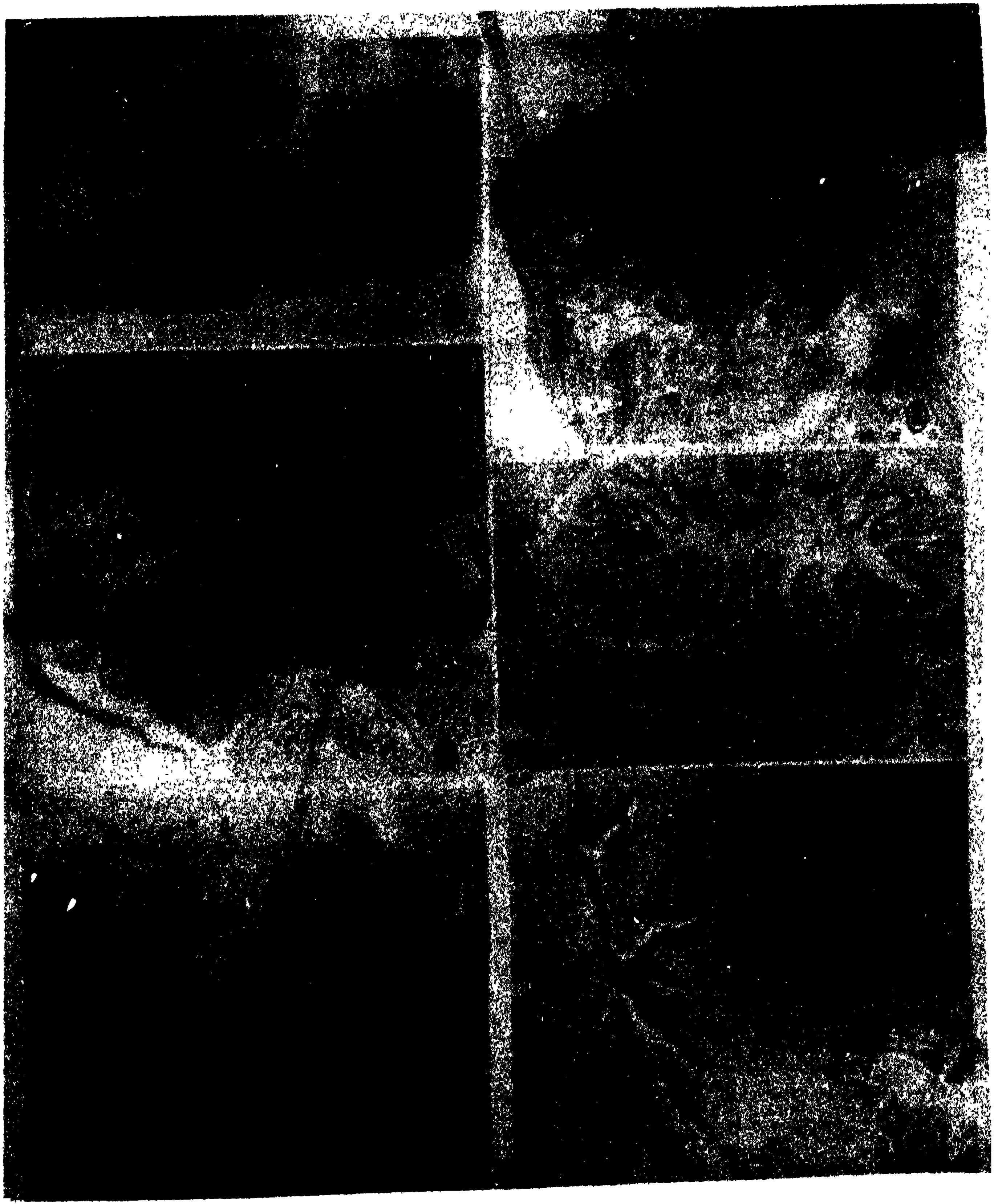
Seasonal variation of the oviduct of a common non-poisonous snake, *Amphiesma stolata* (Linnaeus)

Snakes have normally evoked awe world over. The chelonians, lacertilians, crocodilians and even the rhynchocephalian sphenodons have attracted more attention by naturalist and scientists than the squamate ophidians. But a few have paid attention to the reptilian oviduct[1-7], particularly the snakes. But no seasonal variations have been earlier recorded on the oviducts of *Amphiesma stolata*.



Figs. 1-6: (1) Section through the infundibulum during breeding period. x 400; (2) Section through the tuba showing glands (arrows). x 600; (3) Section showing corium of uterus during ovulatory period. x 600; (4) Cross section through the vagina during ovulatory period. x 100; (5) Section of vagina showing alveolar glands (arrows). x 600; (6) Section from the posterior vaginal region showing thick circular muscle layer and reduced lumen (arrow). x 400.

7 to 10 adult female snakes were obtained every month over a period of two years (1982-84). Live specimens were collected through snake dealers staying at Baruipur, 24 Parganas, a subarb of Calcutta, West Bengal (23°N; 89°E). Oviducts were dissected out from the specimens. Macroscopic examinations were made immediately and tissues were collected from different parts of the oviduct. Tissues were than fixed in alcoholic Bouin's fluid and subjected to the usual process of dehydration, clearing and paraffinizing. Microscopical sections were cut at 6 m thickness and stained with Delafield's hematoxylin and counter stained with alcoholic eosin.

Oviducts are paired structures. The right oviduct is usually larger and situated more anterior to the left. For the conveyance of the ovulated ova five distinct regions of the oviduct may be demarcated as infundibulum, tuba, uterus, vagina and vaginal pouch[3]. But earlier workers[1,2] divided the reptilian oviduct into four regions. Vaginal pouch was not recorded by them. The two oviducts are mostly separate but they are fused at the posterior part of the oviduct i.e., the vaginal pouch. Dorsally the oviducts are suspended by the dorsal mesentery which is continuous with the peritoneum and binds the vaginal and uterine segments to the mid-dorsal wall and the infundibular segment of the oviduct to the dorsolateral wall. Ventrally the oviduct is bounded by smooth-muscle band.

The height of the inner oviducal folds increases and the diameter of the lumen decreased from the anterior to the posterior portion of the oviduct. But the posterior most part of the oviduct— the vaginal pouch, has an increased lumen and decreased height of the folds.

The oviduct undergoes an annual histological change which is remarkably constant. It corresponds in all essential features to that of *M. Japonica*[4]. The wall of the oviduct is composed of an inner mucosa containing the lining epithelium; an submucosa; a layer of smooth muscle is separable into inner circular and outer longitudinal components; a peritoneal covering i.e. an outer serous coat.

During the ovulatory period (March-June) the columnar epithelial cells of the mucosa of the infundibulum are tall and the folds of the mucous membrane are increased in number and height. The tips of the foldings are more or less pointed. This change is accompanied by a notable increase in vascularity of the whole reproductive tract (Fig.1).

The wall of the tuba, in particular, during the ovulatory period acquires a series of large, transverse folds. The number, height and complexity of branching of the mucosal folds which project into the lumen of the oviduct are increased during this period. During the breeding period, the glands present in the tuba may be correlated with the tubular glands (Fig. 2) of the albumen secreting magnum of the oviduct of pigeon[5]. My findings agree with the observation in *T. carolina*[6].

During the ovulatory period, the uterine lumen is lined by columnar epithelium which consists of nonciliated as well as ciliated cells. The secretion of the gland present in the uterus is supposed to form the shell cuticle of *A. stolata* and perhaps this region is responsible for pigmentation. Uterine glands of the oviduct of *D. tristis* [3] are also described as shell glands. Mucous membrane is folded, but the tips of the foldings are blunt. Epithelium flattens to form an even layer (Fig. 3).

During the peak breeding period only the circular muscle layer is present in the most posterior part of the vagina, where it forms an enlargement due to its greater thickness in this region. The longitudinal layer forms a smooth sheet over the posterior and middle regions of the vagina, but anteriorly it is arranged into longitudinal folds (Fig. 4). At the late breeding period it shows alveolar glands (Fig. 5). Posteriorly, the mucosal folds are high and reduced in number (Fig. 6).

Foldings of the mucous membrane of the vaginal pouch are not very prominent during the breeding period hence the lumen of the vaginal pouch is spacious. The histological structures of vaginal pouch is more or less similar to that of vagina.

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Insecticides synergists against *Culex quinquefasciatus*

The continuous use of synthetic insecticides caused insect pests and vectors to develop resistance in due course of the time. It is often more economical to use synergists with an insecticide than to use the insecticide alone. The present investigation is an attempt to study the synergistic effect of a plant alkaloid, plumbagin with insecticides such as Endosulphan, Methyl parathion, Sumicidin, Termex and Rogor. Plumbagin, an alkaloid isolated from *Plumbago indica*, was obtained from Bio Organics, Madras. The stock solution of 100 ppm of plumbagin, was prepared by dissolving 10 mg of plumbagin in 100 ml of acetone. Similarly, 100 ppm strength each insecticide was also prepared by dissolving 10 mg of the concerned insecticide in 100 ml of distilled water. Then, plumbagin was mixed with each insecticide in 1 : 1 ratio. From this mixture different concentrations of insecticide—alkaloid synergists ranging from 0.00001% to 0.001% were prepared at pH 7 using tap water. One litre of the solution of each concentration was taken in separate containers and 50 final instar larvae of *C. quinquefasciatus* were introduced. The assessment of synergistic toxicity was based on the number of final instar larvae dead in each concentration. The percentage mortality of the final instar larvae was plotted against the concentrations of the insecticides spaced logarithmically and the regression lines were drawn. The median response concentrations were then calculated (LC_{50} values) to compare the toxicity.

Cotoxicity coefficient or Synergistic factor (SF) was calculated using the following formula adopted by Kalyana Sundaram and Das[1].

$$SF : \frac{LC_{50} \text{ value of the insecticide alone}}{LC_{50} \text{ value of the insecticide with the plant alkaloid}}$$

Value of SF > 1 indicates synergism and < 1 indicates the antagonism.

It is found that plumbagin has higher synergistic effect with methyl parathion than in the presence of other four insecticides used (Table 1). The combined mixture of plumbagin and methyl parathion is three times more effective than the exclusive action of each individual insecticide.

TABLE 1 : LC_{50} Values of synthetic insecticides on the final instar larvae of *C. quinquefasciatus* with and without the plant alkaloid, Plumbagin

Name of Insecticides	LC_{50} values of Insecticides alone (%)	LC_{50} values of Insecticides + Plumbagin (%)
Endosulphan	.00005	.00002
Methyl Parathion	.00003	.00001
Sumicidin	.0002	.0001
Termex	.0001	.0002
Rogor	.0005	.0008

Insecticidal activity of methyl parathion is attributed to its capacity for inhibiting the activity of choline esterase in insects. If the acetyl choline is allowed to remain, derangement of the nervous mechanism takes place resulting in death of insects. However, the application of very low doses of methyl parathion favours the formation of certain detoxifying enzymes in the body of insects. But, the plant alkaloids such as pyrethrins, cinerins and jasmoline are said to inhibit the action of detoxifying enzymes in insects and thus maintains the toxic effects of the insecticide[2]. The synergistic effects of alkaloids of seven plants with synthetic insecticides on the larvae of *P. ricini* was studied by Chockalingam and Nalina Sundari[3]. Plumbagin is found to possess JH mimicking substance[4]. Chockalingam *et al.*[5], found that application of plumbagin is useful to control third and fourth instar of *C. quinquefasciatus*. Among the insecticides used termex and rogor showed antagonistic effect with plumbagin on *E. fraterna* (Table 2).

The plant products are not immediately toxic to the insects in low doses[6]. The plant products in combination with insecticides are found to act as better larvicides and thus application of synergistic mixture in the management of insect pest is likely to bring down the cost of pest control operations. However, it is also felt that a real benefit of using synergists can only be de-

TABLE 2 : Toxicity effect of insecticide—alkaloid mixtures on the larvae of *C. quinquefasciatus*

Mixture	Cotoxicity Coefficient	Effect
Endosulphan + Plumbagin	2.500	Sy.
Methyl parathion + Plumbagin	3.000	Sy.
Sumicidin + Plumbagin	2.000	Sy.
Termex + Plumbagin	0.500	An.
Rogor + Plumbagin	0.625	An.

rived if the synergised toxicants can be used on agricultural crops. The work relating to the estimation of residues of synergists when admixed with various insecticides is an important step towards a practical utilisation of these materials[7]. More and more information on the fate of synergists along with that of the toxicant is essential in order to recommend the use of synergists in a big way in the management of the mosquito larvae.

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Insecticidal properties of some indigenous plants against stored grain pests

Laboratory experiment was conducted to explore the contact toxicity of oil fraction of seeds of *Clerodendrum viscosum* Vent (Syn. *C. infortunatum* Linn., Fam. Verbenacae) and *Blumea eriantha*. DC (Compositae) against stored grain pests *Callosobruchus chinensis* Linn. and *Sitophilus oryzae* Linn. *C. viscosum* was found to be most effective (LD_{50} = 2.15% conc.). All parts of *C. viscosum* have a bitter pungent taste and are used as bitter tonic, vermifuge and laxative[1]. *B. eriantha* yields an essential oil possessing a comphor—like smell and consisting of chiefly of d-carvotan-acetone, and erianthin, $C_{20}H_{20}O_3$. We were, therefore, interested to investigate the insecticidal effect of oil fractions of two plant species against two stored grain pests[3-5].

Dried and powdered seeds of two plants were soxhleted respectively with solvent Petroleum-ether (60-80°C) for 72 hr. The solvent was removed by distillation and residue left in two cases respectively were taken in least amount of benezene and chromatographed over neutral alumina. The petroleum-ether eluent (60-80°C) from two separate columns were collected. The solvents were removed completely from eluent under reduced pressure and the oily material obtained were again diluted with petroleum-ether to prepare solution of different concentrations 5%, 2.5%, 1.25% and .625%.

The toxicity assessment were done as follows : 1/4 ml of test solution (for a particular concentration) was taken in a dry test tube and the solvent was evaporated prior to insect release. Ten newly-emerged insects were then inserted in the treated test tube which was then covered. After 24 hr, the test insects were transferred to sterilised food (green-gram, wheat grains) and the mortality counts made every 24 hr for three days. One petroleum-ether control and a blank test tube (normal) with insects were run simultaneously. There were four replications for each concentration. All the experiment were carried out under normal temperature (31°± 1°C).

The regression equation was worked out between the concentration of extract and amount of mortality by probit regression analysis[6]. The statistical significant variation among the means were measured, using analysis of variance (F-test).

The oil fraction of *C. viscosum* (Table 1) caused 100% mortality of *C. chinensis* within 24 hr at a concentration of 5% and within 72 hr at a concentration of 2.5%, whereas 100% mortality of *S. oryzae* was brought by both the concentrations within 72 hr. Oil fraction of *B. eriantha* caused mortality of *C. chinensis* 65% at 5% concentration and 40% mortality at 2.5% within 72 hr of treatment. More or less similar results were obtained in case of *S. oryzae* (Table 2). Employing F-test, it

TABLE 1 : Contact toxicity test of seed oil of *Clerodendrom viscosum* against two stored grain pests

Pest	Conc. of oil fraction %	Mortality of stored grain pests of different replications (hr)												LD_{50}
		24				48				72				
		R_1		R_2		R_1		R_2		R_1		R_2		
		I	II	I	II	I	II	I	II	I	II	I	II	
C. chinensis	5	10	10	10	10	–	–	–	–	–	–	–	–	
	2.5	2	4	9	4	2	2	x	x	x	2	1	x	
	1.25	5	2	4	2	x	2	x	x	x	2	x	x	2.15
	.625	x	3	1	1	2	x	1	1	x	x	x	x	
	Control	x	x	x	x	x	x	x	x	x	x	x	x	
	Normal	x	x	x	x	x	x	x	x	x	x	x	x	
S. oryzae	5	8	4	10	6	2	4	–	2	–	2	–	2	
	2.5	5	2	x	3	x	x	6	4	x	x	x	x	
	1.25	x	x	3	2	4	4	2	x	x	x	x	2	2.3
	.625	x	x	x	x	3	2	1	1	x	x	x	x	
	Control	x	x	x	x	x	x	x	x	x	x	x	x	
	Normal	x	x	x	x	x	x	x	x	x	x	x	x	

x : No mortality

TABLE 2 : Contact toxicity test of seed oil of *Blumea eriatha* against two stored grain pests

Pest	Conc. of oil fraction %	Mortality of stored grain pests of different replications (hr)												LD_{50}
		24				48				72				
		R_1		R_2		R_1		R_2		R_1		R_2		
		I	II	I	II	I	II	I	II	I	II	I	II	
C. chinensis	5	4	2	x	5	2	2	5	2	x	x	2	2	
	2.5	3	2	2	x	2	x	x	4	x	2	1	x	
	1.25	x	x	4	3	3	4	x	x	x	x	x	x	3.4
	.625	x	x	x	x	x	x	4	2	x	2	x	x	
	Control	x	x	x	x	x	x	x	x	x	x	x	x	
	Normal	x	x	x	x	x	x	x	x	x	x	x	x	
S. oryzae	5	5	3	2	5	2	x	2	2	x	x	x	x	
	2.5	4	3	x	2	4	3	x	x	x	x	x	x	
	1.25	x	x	4	2	2	2	x	3	x	x	x	x	4.1
	.625	x	x	2	2	3	3	x	x	x	x	x	x	
	Control	x	x	x	x	x	x	x	x	x	x	x	x	
	Normal	x	x	x	x	x	x	x	x	x	x	x	x	

x : No mortality

was further revealed that higher concentration of oil fraction initiated mortality at an increasing degree with a statistically significant variation among the doses used. The LD_{50} of oil fraction of C. *viscosum* against C. *chinensis* was more effective (LD_{50} = 2.15% conc.). *S. oryzae* was less susceptible to these oil fraction in comparison with C. *chinensis*, though there was no significant variation between the finding of these two insects. Analysis of variance (F-test) between the two insects was insignificant at 5% level, whereas the different doses was significant at 1% level. Since no constituents of these plants have been reported to have insecticidal (contact poison) properties, the examination of insecticidal or their synergestic activity should be looked into. Experiment in this area is underway.

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Bioenergy from Agro-Industrial By-products and Waste

The increased agricultural production achieved in recent years has given rise to a variety of environmental problems. Some of the methods used in handling, treating and disposing of agricultural wastes affect the quality of the environment. It is essential to understand these problems and to work out suitable control measures[1].

Agricultural wastes originate from food processing, crop and field residues, dead livestock, canning and packaging industry etc. Most of the agricultural and other organic wastes are suitable for biogas generation and thus for energy production[2-3]. The depletion of fossil fuels, increasing per capita energy consumption and rapid growth of population have prompted searches for alternative source of energy. Among the non-commercial sources are firewood, agricultural wastes and animal dung.

The process for energy recovery may be classified into two groups (Fig. 1) : (1) biological processes and (2) thermochemical processes.

Aqueous Process : This is an entirely biological process in which microorganisms consume the nutrients present in the wastes to increase their own biomass and consequently release various combustible and non-combustible gases and/or simple carbohydrates. In the anaerobic process, there is a deficiency of O_2 and hence the entire carbon is not converted to CO_2, the products of respiration being CO_2, methane and various products of reduction. On the degradation of the waste, CO_2 and CH_4 are released to the atmosphere, the O_2 demand is reduced and the waste gets stabilized. Under standard conditions, the production of 1.4 to 1.69 m^3 of methane results in the stabilization of 0.5 kg of utilimate O_2 demand[4].

Waste resources and recoverable energy: A large number of rice mills, sugar mills, distillaries, canning industries, fisheries, meat processing units and other food industries are in operation in the country. Daily availability of a

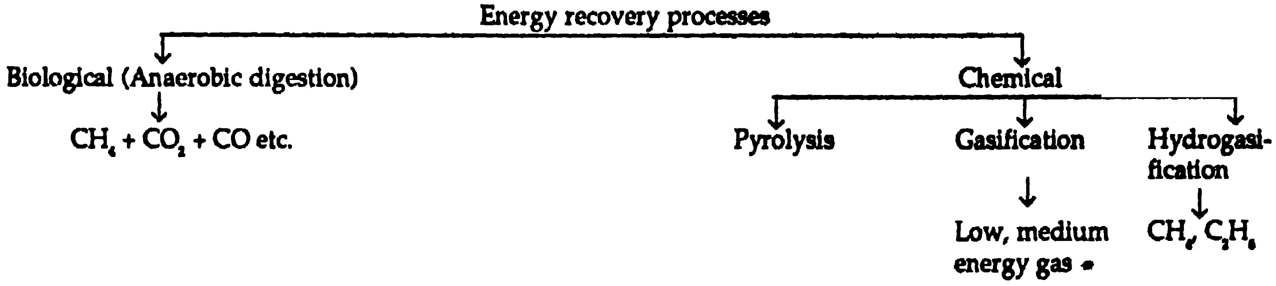

Fig. 1. Process for recovery of energy from agricultural wastes

few major food processing wastes is given in Table 1. Because of the non-availability of adequate information waste generated by individual industry could not be computed. Availability of bioenergy/biogas per unit weight of the waste is computed and given in Table 1. It appears that although these are important resources, they are not exploited for small scale bioconversion into methane.

TABLE 1 : Computed daily availability of biogas from waste and its energy equivalent (1986 data)

Source	Availability (kg/day)	Volatile solids (VS) (%)	Digestible Volatile solids (%)	Total biogas yield L/kg waste	Total biogas yield L/kg VS	CH_4* yield L/kg waste	Energy equivalent Kcal/kg
Fruit and vegetable processing waste	12.1×10^4	82	73	450	640	224	1775
Dairy and meat processing sludge waste	6.8×10^6	80	68	240	400	142	1130
Fisheries	6.1×10^5	74	70	260	510	170	1350
Rice mill (Husk)	47.2×10^6	74	70	185	420	125	1000
Sugar mill (Bagasse)	17.2×10^6	65	65	150	410	100	780
Distillaries	16.0×10^5	75	67	140	325	100	750
Algae	6.2×10^5	80	75	365	685	260	2100

* Based on 66% methane content in biogas.

Basic Technology of refuse bioconversion : Essentially a single stage biogas plant consists of two units. First, a digester with an inlet into which the waste materials are introduced in form of a slurry. In the digester bioconversion of refuse in carried out at 33-40°C. The second unit is a gas holder to collect biogas containing 60-70% methane as combustible component, the rest being mostly carbon dioxide. In a typical anaerobic bioconversion process to generate biogas in the digester the complex organic materials are degraded in a sequence of two steps mediated by two different types of microbial flora. In the first liquefaction and acidification step acidogens play role for nearly seven to ten days. Liquified acidic materials are acted upon by methane-forming organisms in the second step and digestion is completed by another five to eight days. Improvements of this basic technology of biogas production have been made and thereby digestion time have been reduced and methane productivity has also been increased to a great extent[5]. The digested slurry from the biogas producer containing essential farm nutrients (N : P : K : : 4 : 3 : 1) can be used as bio-fertilizer directly in the agriculture. Alge cultivated in the pond utilizing solar energy may be directly fed in the biogas producer to met daily requirements of biogas as fuel for boiler operation. So the production of biogas and biofertilizer from waste will make the food processing plant technically as well as economically more viable.

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Growth performance and reproductive behaviour of *Convolvulus arvensis* Linn. in relation to soil salinity

Soil salinity and alkalinity play an important role in distribution, behaviour and existence of plants in nature[1]. Existence of a species in a habitat depends upon its reproductive capacity[2], for example, on viable seed production and the capacity for production of a high-percentage potential progeny. Our understanding of this aspect of plant behaviour under saline habitat is still quite meagre. This communication deals with the growth performance and reproductive behaviour of diverse population of *Convolvulus arvensis* Linn.

C. arvensis, an annual weed belonging to the Convolvulaceae, is widely distributed in all temperate and subtropical regions of the world[3,4]. It appears in cold season (winter), very common in black soil and is a valuable fodder[5] inhabiting both saline and non-saline habitats by virtue of its having high salt adaptive potential[6].

Three experimental plots each were selected in non-saline and saline habitats. After germination of seeds in Nov. 1985, the plots were protected with 1 m^2 wire-net fence and weeding was done to avoid interspecific competition. Observations were started from the seedling stage and continued till the fruiting stage. At fruiting stage, 10 plants from each plot were sampled by digging monoliths and were made soil-free in running tap water. Shoots and roots of each plant were dried separately for 72 hr at 60°C in a hot-air oven for dry matter (DM). Counts were made for the number of inflorescence/plant and number of seeds/inflorescence. The average seed out-put/plant was computed as :

$$\text{Average seed out-put/plant} = \text{Average number of inflorescence/plant} \times \text{Average number of seeds/inflorescence}$$

Seeds were separated from mature inflorescence by hand to determine the average seed weight, weighed in lots of 100 and placed in petri-dishes containing moist filter papers for germination. There were three replicates for each type of seeds and each dish contained 50 seeds. Germination tests were performed in the laboratory under 8 hr of photoperiod with flourescent lamps supplemented by 15-W incandescent bulbs and kept at a distance of 1 m from dishes with the temperature ranging between 24°C and 30°C. Reproductive capacity of plants were determined from the seed output/plant and percent germination[2] as follows :

$$\text{Reproductive capacity} = \text{Average seed output/plant} \times \frac{\text{Average percent seed germination}}{100}$$

The growth performance indicated superiority of the plants of the non-saline habitat over the saline habitat with respect to foliage development, shoot length and the biomass (shoot and root DM) accumulation (Table 1). Branching capacity, shoot/root ratio, number of inflorescence per plant and average number of seeds/plant was greater in plants of saline habitats than those of plants of normal habitats.

Seeds of the plants belonging to saline habitats were heavier than those from normal

TABLE 1 : Performance of *C. arvensis* occurring on non-saline and saline habitat (All values are averages)

Parameters	Non-saline habitat	Saline habitat
Length of longest shoot/plant (cm)	32.25 ± 4.00	12.65 ± 2.30
No. of leaves/plant	280 ± 5.50	162 ± 6.00
No. of branches/plant	12 ± 2.00	18 ± 2.00
Shoot dry weight/plant (gm)	7.25 ± 1.20	3.05 ± 1.00
Root dry weight/plant (gm)	3.56 ± 1.00	0.72 ± 0.02
Total dry weight/plant (gm)	10.81 ± 0.14	3.77 ± 0.69
Shoot/root ratio	2.04 ± 0.10	4.25 ± 0.49
No. of inflorescence/Plant	3.60 ±1 2.00	450 ± 7.00
No. of seeds/inflorescence	1 ± 0.00	1 ± 0.00
Seed output/plant	360 ± 12.00	450 ± 7.00
Seed weight (mg)	0.62 ± 0.03	0.72 ± 0.02
Germination percent	86 ± 200	76 ± 3.00
Reproductive capacity	309.60 ± 7.07	342.00 ± 2.83

± indicates standard deviation.

habitat. Plants of saline habitats possessed higher reproductive capacity than those of plants of normal habitats. An analysis of the behaviour pertaining to the ecesis of *Convolvulus arvensis* in normal and saline habitats during wet season reveals halophytic potential of the species. Accumulation of water-soluble salts, low water potential, decreased water supply and low water availability have been considered responsible for poor growth performance of the species in saline habitat. Low number as well as smaller size of leaves in plants of saline population reflects an adaptation to avoid excessive water loss through transpiration which is also indirectly related to decreased photosynthesis concomitant with increased respiration[1]. Suppressed net assimilation resulting this way causes a reduction in dry matter accumulation/plant. Relatively higher shoot/root ratio for individuals of species in saline habitat is ascribed to poor root growth caused by poor aeration and ion toxicity. An increase in branching in plants of saline habitats reflects development of a tendency to more seeds ensuring survival in the harsh edaphic environment. Production of heavier seeds by the plants unquestionably point to their adaptation to saline habitats where germination and establishment call for better insurance against the prevailing water shortage. Heavier seeds have also an understanding advantage of sufficiency of reserve food materials to enable the seedling to survive better after germination. A high average seed output/plant and a high reproductive capacity in plants of saline habitat indicated a salinity induced preadaptation making the species genetically better equipped for ecesis in the saline habitat.

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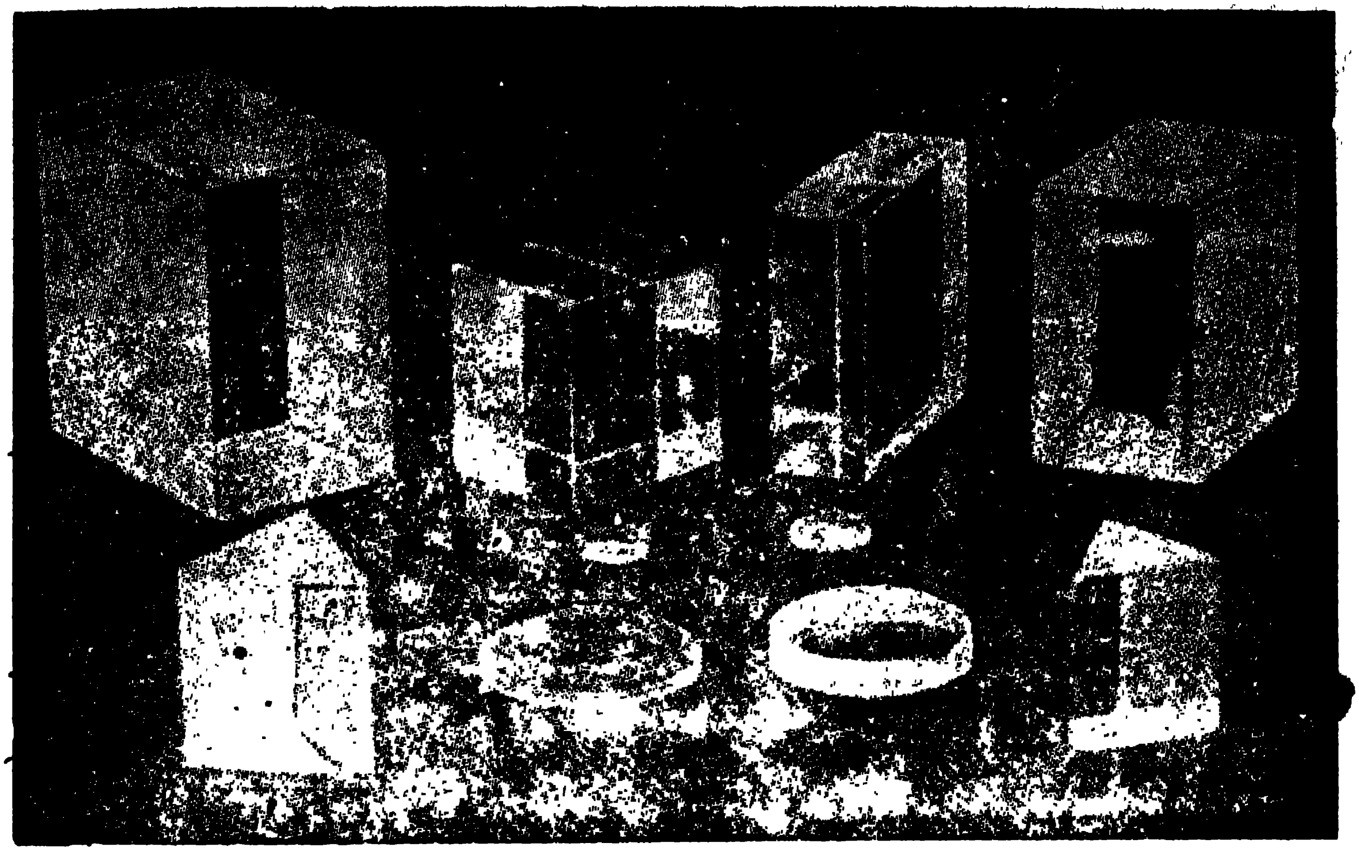

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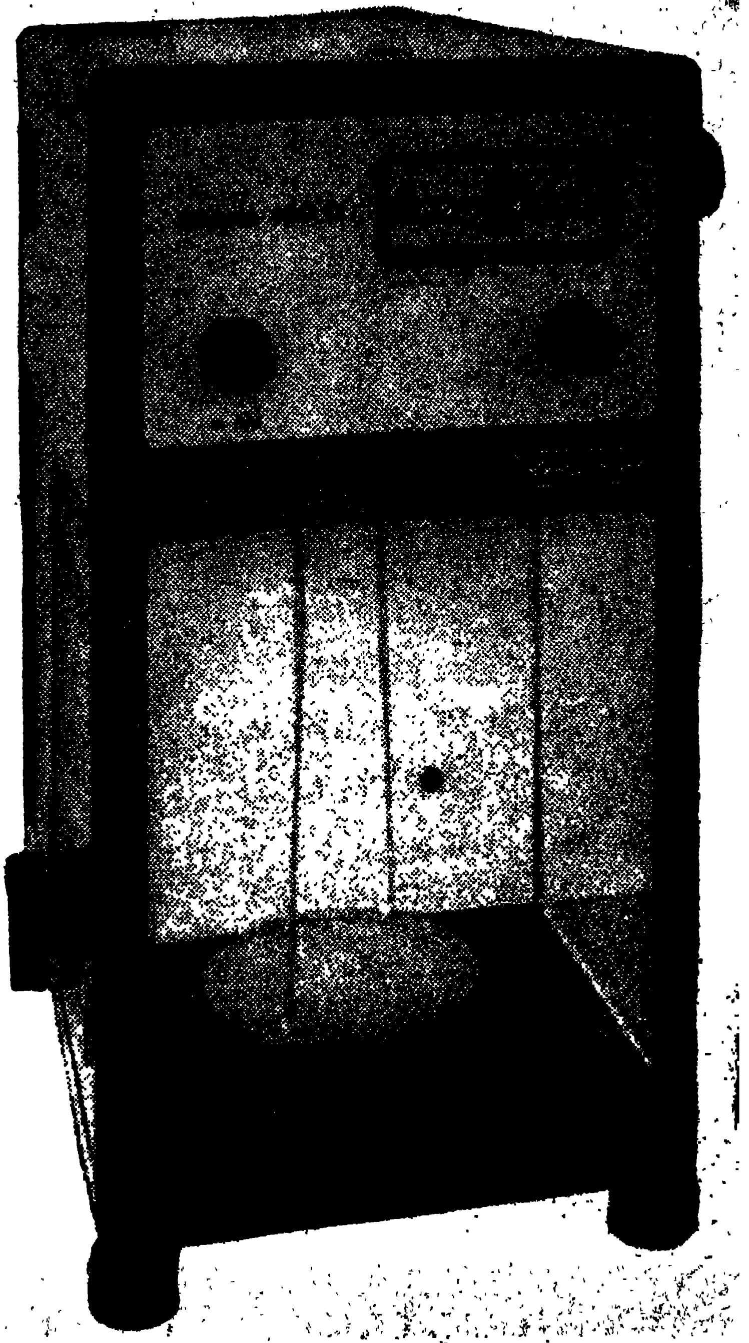

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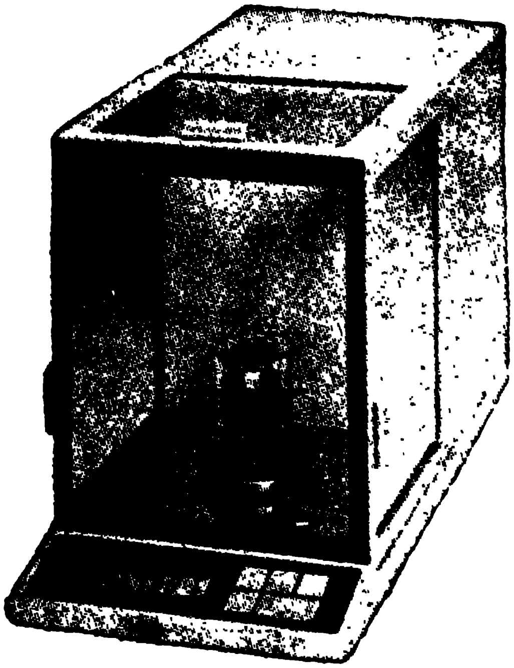

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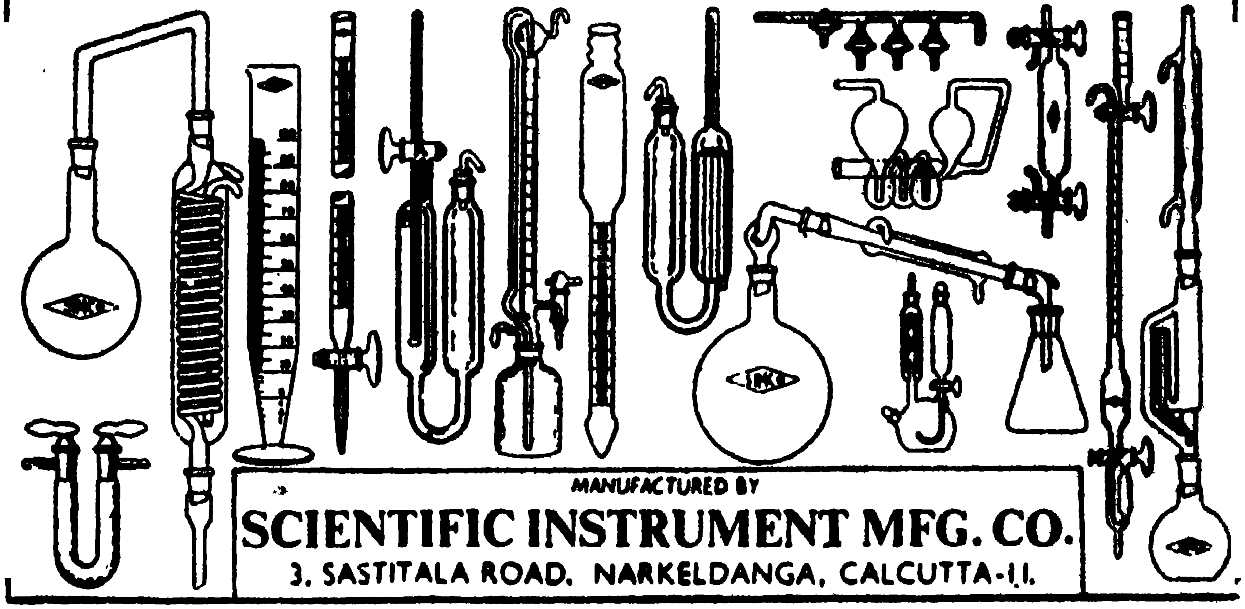

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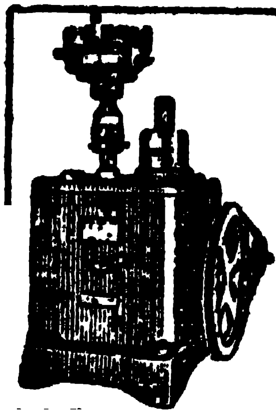

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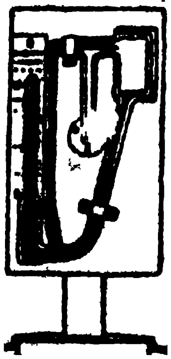

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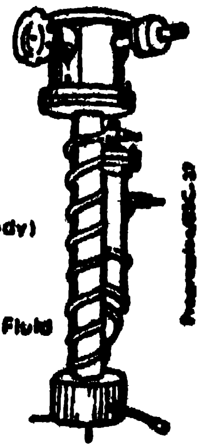

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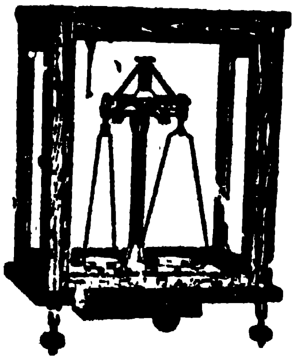

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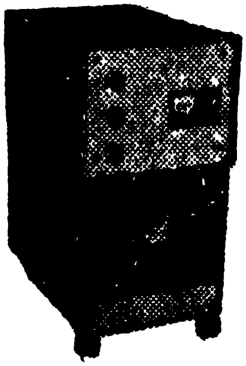

SCIENCE &
CULTURE

VOLUME 54 ☐ JULY 1988 ☐ NO. 7

OUR SPACE PROGRAMME DISARRAYED

THE failure of the second Augmented Satellite Launch Vehicle (ASLV) on July 13, 1988, to take off from Sriharikota Space Station has brought in varied reactions from different quarters. This successive failure following the one of March 1987 was a great disappointment not only to the scientists, connected with the programme but also the layman who were keenly awaiting a successful launch. Whether the general public understands the full implication of the space experiments or not, is not the question, but by and large these experiments of big science are being looked upon as a symbol of national prestige and it is that it has hurt the most. The reassurance of the Prime Minister at the time of the first failure last year that "it is only when you stumble you get up and walk better" had been accepted quietly but the disappointment at the second failure cannot be quietened so easily. Many are the questions asked as to how many more stumbles will be required to lead the Space Agency to a steady walk.

Each of these trials must have cost several crores of rupees which went up in smoke within seconds of the blast off. Earlier too there were two failures in the SLV series out of the four and it is the pious hope that the remaining two ASLV missions which are scheduled may follow the earlier trend set for SLV.

The ASLV is a five stage vehicle with two strap-on rocket motors flanking the main vehicle. These strap-ons constitute the 2nd stage. This and the four stages of the core vehicle constitute the five stages of ASLV.

In the ASLV mission on July 13th the strap-ons did ignite at the appointed time of 0.0 seconds and they behaved very well. The first stage motor also fired at the scheduled time of 48 seconds after the lift-off. However, there was abnormality in the performance five seconds later by that time strap-ons should have separated from the core vehicle.

According to scientists observing the blast off, "visually, we felt that the strap-ons did not separate. But the telemetry signals showed that they separated. There may be an anomaly .... It has to be removed. It will take several weeks to look at the voluminous data and arrive at the exact cause of the failure".

The reporters present have also gathered other surmises from ISRO sources which might be the probable causes of the failure : the strap-ons could have jettisoned, but the first stage motor must have under performed; the strap-ons might not have separated; one strap-on could have separated but not the other; or the strap-on could have disconnected later than scheduled. These are intelligent guesses which have to be supported by the recorded data to identify the real cause.

It is galling that the trouble on July 13 was once again in the first stage. On its maiden flight during March 1987, the first stage motor failed to ignite after the newly developed strap-on motors had carried the vehicle to almost 10 km into space. In the July round the first stage motor ignited but developed flaw after four or five seconds. It is indeed a tragedy in the sense that the first stage motor was a proven entity (until recently) unlike the strap-on boosters. It was used, quite successfully, on the SLV-3 missions and has also been tested several times over on the ground. Initial analysis of the present failure indicate that the strap-on motors, which ought to have separated from the vehicle once they had spent themselves out, about 52 seconds into the flight may not have done so. This dead weight which the first stage motor had to haul was too much for the efficiently balanced capacity of it.

In the coming months, the scientists at ISRO will no doubt review this short lived flight, to analyse what really went wrong. However, the situation now is no better than what it was during the first disaster. The Failure Analysis Committee which went into the cause of the failure of the first flight, could not pinpoint the defect, in spite of the fact that it was aided by as many as 77 specialist sub-committees. The main handicap was that they could not lay their hands on the debris of the rocket. This time too the Chairman Dr. U. R. Rao has catagorically ruled out the salvaging of the rocket remains from the depths of Bay of Bengal, because of the costs involved in the operation. Unless some clinching clues to the disaster are obtained in the analysis, the decision about salvaging may have to be revised. ISRO cannot afford to go into the next ASLV flight on more conjectures, or most likely (hopeful) causes or plain prayers. The exact cause of the disfunction has to be determined before the next flight is scheduled.

One more conjecture worth investigating in depth concerns the functioning of the first stage motor itself. In March 1987, it failed to ignite and in July 1988, it ignited but misbehaved. These symptoms point out to the fuel and the injection system. Some experts assign the cause of sputtering of the first stage motor after ignition to the partial ignition of the fuel in the rocket cylinder which in turn point to the quality and nature of the fuel.

The first stage motor carried liquid hydrazine fuel under pressure, in contrast to the strap-on boosters which carried solid fuel. Hydrazine is a complex petroleum derivative and since the exact mix in the components in it varies in different space programmes, the experts could not tell what was the composition of ISRO's hydrazine.

If there is any truth in this theory, it may not be necessary to salvage the debris of ASLV-D2 to determine what went wrong. The fuel need to be analysed more thoroughly from wherever it came.

In one section of the press comparisons were made with the failure in the space programmes of other countries. These comparisons with USA and USSR are irrelevant as our space programme is a pigmy compared to theirs. Similarly Japan and France have considerably larger programmes. The Chinese effort which is a modest one has a (known) failure rate of about 20 per cent, whereas ours with four failures out of six attempts is pretty high. Thus we have crossed the stage of taking solace in such comparison.

The question to be parried at this time is the financing of the space programme. Its allocation for this year is Rs. 430 crores which may not give the actual picture. To the total loss in each failure one has to add the cost of R & D of each part of the space programme. According to one estimate it may add upto Rs. 2000 crores in rocket development alone to put a telecommunication satellite into geostationary orbit. For any full scale space programme this financial undertaking is inherrent. However, considering the resources of our country, this is a tall figure. There already exists resentment over disproportionate allocation of funds for a few programmes like atomic energy and space, which may become more vocal and pressure may build up for revision of certain priorities. Thus for the coming few months space scientists will have to work with the added stress of accountability.

The failure of the first two ASLV missions have cast doubts on the schedule of the other two which have been planned for 1989 and 1990. Now according to the Chairman of ISRO, these will be rescheduled only after going fully into the cause of the failures. However, he feels that our programme of Polar Satellite Launch Vehicle capable of putting 1000 kg remote sensing satellite into 1000 km sun-synchronous orbit would not be affected. It is heartening to see such trust and confidence which is essential for the success of the space programme. □

B. B. Baliga

MILLIMETER WAVE PROPAGATION *

S. N. GHOSH**

Propagation in the millimeter range is a possibility for future communication. British Post Office has already indicated it. The apparatus will be small, lightweighted. It will afford a large number of channels to be operated simultaneously. The propagation is efficient if carried in the window that exists in the millimeter wave range e.g. at 94 GHz.

1. Introduction

WITH the progress of time electromagnetic waves find wider applications, thereby causing the traffic to exceed the frequency allocation, producing congestions in the frequency spectrum. To eliminate this difficulty the existing frequency bands for propagation are pushed beyond its limits ultimately necessitating, the introduction of millimeter waves. Such waves are less susceptible to interference.

Strictly speaking, waves having wavelengths between 10 mm and 1 mm or in frequency scale from 30 GHz to 300 GHz are called millimeter waves. They are usually denoted as the 'mm waves'. Unlike radio frequency waves which are almost transparent to atmosphere, mm waves are absorbed by atmospheric gases.

2. Propagation of mm waves

The selection of working frequencies for propagation depends on occurrances of windows where absorption lines are absent or are few in number. There are certain absorption bands where atmospheric gases offer considerable attenuation to mm waves. These are :

(i) Water vapour (asymmetric rotor) absorption in the vicinity of 22.24 and 183.37 GHz having absorption coefficients 9.6×10^{-6} and 8.1×10^{-3} cm^{-1} respectively.

(ii) Oxygen molecular absorption 53.59-65.17 and 120 GHz having absorption coefficient varying between 3.5×10^{-5} and 1.5×10^{-6} cm^{-1}. O_2^{16} (linear) absorption is due to magnetic rather than electric dipole coupling.

Other absorpting gases are ozone whose absorption lines are scattered throughout the cm and mm wave range, CO which has an absorption line at 115 GHz and certain other molecules. These lines are, however, very weak.

Because of high attenuation by atmospheric gases the operating frequencies for propagation of mm waves are determined by the low attenuation atmospheric windows, for example, those at 35, 94, 140 and 220 GHz. The presence of atmospheric windows reduced attenuation, and military demand for small attenuation and narrow beam width systems have resulted in considerable increased activity in mm wave region.

For communication, different layers of the atmosphere are utilised for different frequency bands. For example, the band between 0.5 MHz to 30 MHz is utilised for propagation of short waves being reflected or refracted by the ionosphere. The mm waves are not affected by ionosphere but in troposphere marked effect on their propagation is noticed. Due to the change in refraction index in the troposphere the waves bend.

In addition to molecular gas absorption, the attenuation of mm waves in this region is caused by three factors :

(i) Scattering by collection of molecules as in light haze,

(ii) Absorption and scattering by solid particles like dust, smoke etc. (dry haze),

(iii) Absorption by precipitated particles (hydrometers) e.g. rain, fog, snow and hail. Precipitation is the particle of liquid water or ice formed within a cloud and falling towards the ground. It may not reach the ground and may evaporate on the way passing through the atmosphere. These latter absorption due to hydrometers are much higher compared to molecular absorptions.

---

* Based on a talk delivered on Dec. 23, 1986 at Applied Physics Department, Calcutta University on the occasion of the Diamond Jubilee Celebration of the Department.

**Department of Applied Physics, Calcutta University, Calcutta-700009

3. Attenuation of mm Waves During Rain

When mm waves propagate through the troposphere, due to change in refractive index (m) the waves bend. Again, mm waves after reacting with water droplets cause a displacement current which is large and directly proportional to the frequency (f) of waves. Since the radius (r) of water droplets during rain is comparable to mm wave length of the droplets, their presence in the path also affects attenuation of mm waves. Therefore attenuation cross section due to rain

$$Q = f(r, \lambda, m).$$

Several investigators have studied the distribution of rain drop sizes as a function of rain rate and the type of storm activity. The drop size distribution can be represented exponentially

$$n(r) \qquad N_{-}\, e^{-[CR^{-d}]r}$$

where R— rain rate in mm/hr
r — drop radius in mm
N_o—constant to be determined from measured distribution.

The three distributions often referred to are those of (1) Laws and Parsons (2) Marshal and Palmer and (3) Joss *et al.*

Attenuation of mm waves during rain being large, imposes a severe limitation in establishing a radio link at mm waves. The clean air attenuation of mm waves at 94 GHz for horizontal path has a minimum value of 0.4 dB/km, and shoots up to about 10 dB/km for a rainfall rate of 25 mm/hr and 40 dB/km for 150 mm/hr rain rate. During monsoon month, rainfall rate attains the highest value. Theoretical estimates of rain attenuation in the frequency range 30–300 GHz have been made for various rain rates and drop size distributions and compared with experimental values.

4. Generation of mm Waves

(i) *J. C. Bose's Work*: In 1894 Prof. J. C. Bose generated at Calcutta mm waves by spark excitation. The wavelength used by him varied from 5-25 mm. Many quasi-optical experiments on reflection, refraction, total reflection, polarization, rotation of the plane of polarization etc. could be demostrated by his compact apparatus mounted on an ordinary spectrometer table (Fig. 1). He constructed a reflecting metal strip concave grating with which he measured the wavelength of the waves. He made many important observations on the polarization of mm waves by double refraction in some crystals. The most important polarisers and analyses were made of pressed jute fibres.

Fig. 1.

In Feb. 1958 issue of *Proc. IRE*, Ramsay published a review of contributions of Hetz, Lodge, Righi & Bose, who were the founder investigators of generation and detection of e.m. waves. Special importance was given to Bose for enclosing his emitter of mm wave in cylindrical and rectangular metal tubes, a precursor of waveguide. Bose worked on mm wave for 5 years upto 1899.

With the development of electron vacuum tubes this technique was superseded by microwave generators, klystron, magnetron, travelling wave tubes and other microwave tubes. The use of metal and dielectric wave guides microstrip lines and integrated circuits are extended from microwave to mm range.

Certain difficulties are experienced in extending the range of microwave tubes into the mm wave region, namely;

(ii) *mm Wave Link at Calcutta* : A mm wave link has been set up between Radio Physics Department and the Centenary Building of Calcutta University (Fig. 2). A 50 mW CW IMPATT oscillator at 94 GHz fed to a 50 dB horn antenna is employed at the transmission. At the receiving station a superhetrodyne receiver fed from a 25 dB horn receives the 94 GHz signals. The rain attenuation can be as large as 40-60 dB per km during extreme rain rates. This large attenuation calls for a highly sensitive receiving system. To achieve it the signal is chopped by a rotating vane chopper placed in front of the receiving horn. The output of the detector at the chopping frequency of 1000 Hz is amplified by a narrow band amplifier and detected by a phase sensitive detector (PSD). The 1000 Hz local oscillator frequency from the PSD is derived from the generator driving the chopper. The D.C. output of the PSD is intigrated with a time constant of 1 sec by a D.C. amplifier and recorded. The receiving system is similar to a Dick type radiometer.

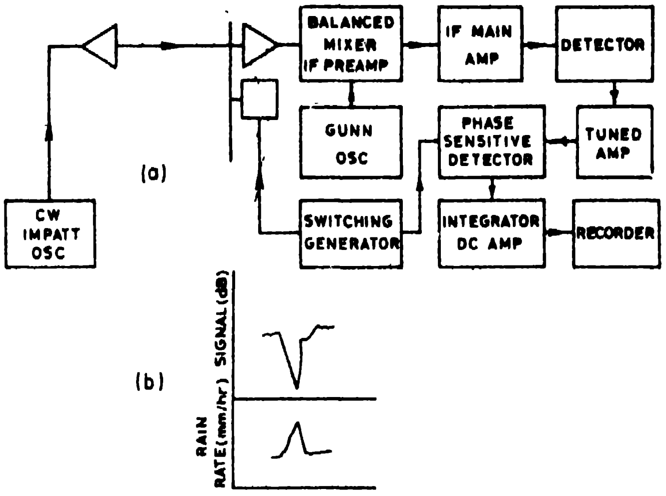

Fig. 2

Round the clock recording of the signal strength at the receiving station was undertaken with a chart speed 10 cm/hr. The rain rate was measured by a fast rain gauge having a response time of 10 sec. The peak rain attenuations are plotted against the respective peak rain rates (Fig. 3).

If the particles settled in air at extremely low wind speeds are of smoke and dust, they produce haze, and if of water or ice, then a mist or fog appears.

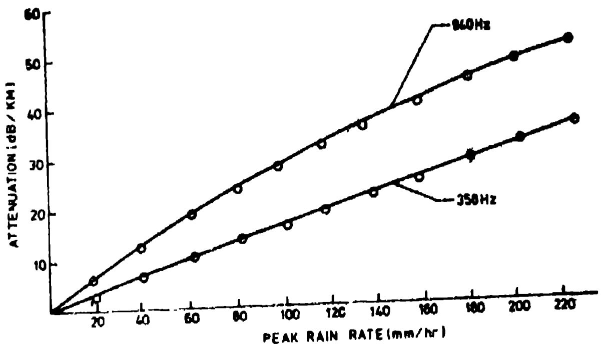

Fig. 3

Figs. 4 and 5 show the attenuation of cloud and fog as a function of wavelength, and cloud attenuation as a function of elevation angle, for clear, mixed and cloudly sky, respectively.

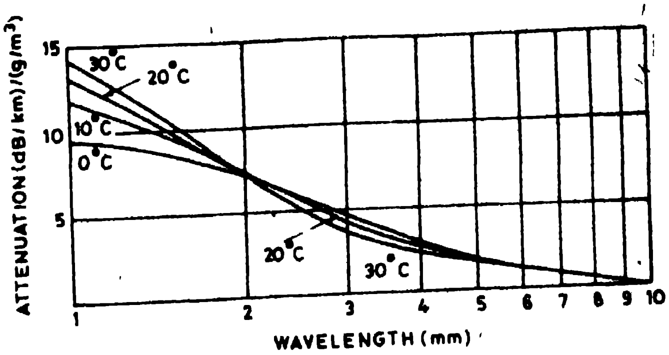

Fig. 4

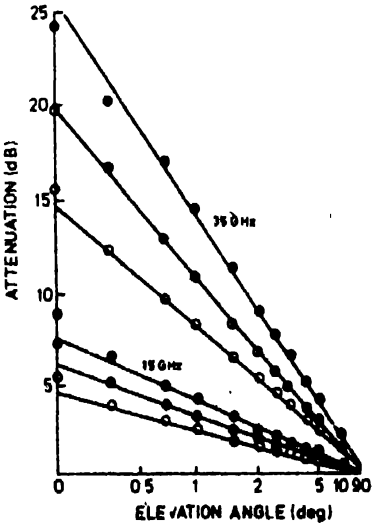

Fig. 5

5. Features of mm Waves

Increased interest in the utilization of mm waves is justified by certain specific features of this frequency band namely,

(i) Increased bandwidth
(ii) Smaller size equipments specially the antennas are required thereby increasing adaptibility for being mounted on smaller light-weighted survelliance platforms
(iii) Smaller antenna diameter for the same gain and bandwidth
(iv) Immunity to noise
(v) Immunity to electromagnetic interference
(vi) Increased angular resolution for the same antenna diameter
(vii) Increased sensitivity to Doppler velocity effect
(viii) Increased immunity to unwanted detection by hostile forces
(ix) Increased immunity for frequency interference and hostile interference because of the smaller beam width of the antenna
(x) Ability to penetrate smoke, dust etc. Hence mm waves are logical choice for adverse conditions with obscurants in the propagation path e.g., battlefield smoke. In winter times when the sky of Calcutta is overcast by smoke screens, mm waves can easily pass through them.
(xi) Molecular absorption is basically a handicap but can provide solution to some special problems e.g. air pollution studies and secret military communication.
(xii) Communications systems using mm waves have been perfected for both military and civil applications.

6. Application of mm Waves

The attenuation of mm waves offers important applications in radar and communication (civil and military), radiometry and instrumentation for scientific investigation.

Some of the important applications are :

(i) Low angle tracking
(ii) Remote sensing of environment
(iii) Use in cloud scanning radar
(iv) Point-to-point broad band communication
(v) Secret military communication
(vi) Use in astronomy
(vii) Plasma diagonastics
(viii) Sea ice detection.

Other applications of mm waves are :

(i) Communication link through plasma. A 100 GHz system would substantiate a communication link through plasma sheath which is opaque to waves having usual communication frequencies.
(ii) mm wave radar applications in airport survey, harbour traffic control, short range surveillance
(iii) mm wave control of reagents and cata-lysts.

7. Conclusion

There are at present two frontier problems of communication, namely (1) mm wave propagation (2) fibre optics communication. The British Post Office has already indicated the use of mm waves as a possibility for future communication. Also, a great amount of investigation is being carried out on fibre optics as a means for communication.

I wish to place on record the pleasure of working with Prof. A. K. Sen of the Institute of Radio Physics and Electronics, Calcutta University who with a band of associates, are maintaining the 94 GHz mm wave link at Calcutta. □

Notes and news

Seminar on Astronomy and Mathematics in Ancient and Medieval India

A Seminar on astronomy and mathematics in ancient and medieval India to have a dialogue between traditional scholars and university trained scientists was held on May 19-21, 1987 at the Premananda Hall of the Ramkrishna Mission Institute of Culture, Calcutta. The seminar was organised under the joint auspices of the Asiatic Society and the Indian Council of Philosophical Research.

The seminar was inaugurated by Swami Lokeswarananda who noted its novel character in its attempt to hold a dialogue between traditional and modern scholars. He particularly appreciated the remarks of Prof. A. K. Saha, Chairman of the Organizing Committee, about dialogues as distinctive forms of debates to clarify intellectual problems in ancient and modern times. Prof. A. K. Saha explained that the seminar had been structured into three broad areas concerned with (a) some major themes in astronomy in ancient and medieval India, (b) similar themes in mathematics and (c) a special dialogue between philosophers and traditional scholars and university trained scientists. Dialogues, he maintained, had always constituted an important method for enlarging the boundaries of knowledge. In this century one of the most famous dialogues of all times took place between one group led by Albert Einstein and another, the Copenhagen School, led by Niels Bohr about the real nature of quantum mechanics. The dialogue appeared in the form of a series of papers from the two groups which are now classics in the literature on physics. Galileo adopted the dialogue technique when he wrote his 'Dialogue concerning two chief world systems' which ushered in the age of modern science.

Further back, in ancient Greek, Plato preferred the dialogue method in expounding the thoughts of Socrates, although much of the materials presented there concerned Plato's own thoughts, his concept of utopia, theory of ideas, cosmogony and so on. The importance of the dialogue method in India, was fully recognized as the most effective method for the exchange of knowledge between the teachers and the taught. The Samhitas, Brahmanas, and Araṇyakas provide numerous instances of dialogues, but by far the most impressive are those of the Upaniṣads. The *Milinda Panha*, recording a dialogue between Minander and Nagasena, is an instance of Buddhist interest — in this form of exchange of knowledge.

Of the two major subjects of the seminar, astronomy, Prof. Saha thought, was perhaps the first science to be studied in a systematic manner. The study was somewhat handicapped by its association with the requirements of religion and rituals. The case of mathematics was different. It no doubt emerged through the world of experience, but very soon it developed its own intellectual structure and achieved great beauty and profundity only through the consistency of its inner logic.

On the first two days of the seminar the topics were divided in eight sessions as follows : (1) Histriography; (2) Samhitas, epics and puranas; (3&4) Concepts, theories and procedures; (5&6) Problems of mathematics; (7) Problems of astronomy and mathematics; (8) Dialogues on issues in astronomy & mathematics.

The 8th session was chaired by Prof. A. K. Saha who summarised in the first place his reactions to the papers and discussions of the previous seven sessions. He noticed an understandable pride on the achievements of Indian astronomy and mathematics, but was disappointed to find any discussion on the limitations of thinking, equally important for the understanding of the historical development of thought. In his own view, astronomy and mathematics in India were never allowed to be delinked from the damands of utility in practical life such as land surveying, trade, interests, fixation of timings of religious rites and festivals. All this preoccupation was true of mathematical development throughout the ancient world in general, but in Greece and later on in Europe it began to give way to more abstract and fundamental thinking. This did not happen in India. He further thought that this obsession with practical matters was partly responsible for lack of interest among ancient Indian mathematicians in the role of proof in mathematics, and in evolving a deductive method, which characterized Greek mathematical endeavour.

On the nature of mathematics, the main theme of the dialogue, Prof. Saha chose to express the view of the formalists inspired by Hilbert. According to this view, mathematics is the highest abstract product and construction of the human mind, which stands on the basis created by its inner logical consistency, rigid rigour and freedom from contradictions, furthermore, this construction does not need any validation from the universe outside the mind. Sometimes the mathematical constructs may be very strange, as for example, the imaginary quantity $\sqrt{-1}$, but when its mathematical operations were developed, it became useful to the hard headed physicists in introducing brevity and compactness in the analysis of many physical phenomena. Prof. Saha believed that there were other views on mathematics which the learned participants would discuss in the dialogue.

The seminar considered four issues which were presented by key-note addresses and followed by lively discussions.

The first issue 'The nature of mathematical knowledge' was introduced by Parimal Kanti Ghosh. He maintained that the concept of mathematical knowledge could not be fully defined. It is generally admitted that mathematics is to a large extent subjective, an expression of the human mind, its hard core is axiomatic, and it proceeds by intuition and logic to various constructions. Another characteristic of mathematics as a product of the creative mind is that it avoids dogmas. The evolution of mathematics makes it abundantly clear that it proceeds from concrete to abstract and then from abstract to concrete. In this way we see how intigers led to fractions, then the irrationality of the diagonal of a square, the concept of a line as a continuum filled by points, from the finite to the infinite. He also talked of number class relationship, the Jaina conception of number, and Cantor's theory of transfinite. He concluded that mathematics had not found its final philosophy and when it would find it, it would be dead.

V. Shekhawat in his Key paper on "The Nature of Mathematical objects" dealt with the issue no. 2. By mathematical objects he meant arithmetical objects like natural numbers, algebraic objects like sets and variables, and geometrical objects like points and lines. He attempted to explain these mathematical objects in the light of the Indian experience as recorded in the Vaiseṣika sutra, Saṃkhya sutra, Nyaya, the Sūryasiddhanta, Gaṇitasara saṃgraha, Lilavati and Bījagaṇita. As to the concept of number, this is implicit in the enumeration of *gunas* associated with *dravyas* in the Vaiseṣika sutra and Saṃkhya characteristics or laksaṇas. It is possible that the science of enumeration originated with the Saṃkhya Theory. Although Vaiseṣika and Sāṃkhya Sutras both agreed on the reality of number, the important difference is, while the Vaiseṣikas regard number as a property of Kāla, the Saṃkhya exponents treat number as an evolute of Prakṛti or manifestation of buddhi. In other words, the concept of number developed intuitively. This is also true of the concept of arithmetical operations (*Parikrama*). The concept of negative and positive numbers was not possibly intuitive as it can develop, and probably did, in the context of exchange of money, Sekhawat further suggests that Saṃanya in the Vaiseṣika Sutra is close to the concept of a set.

A set in order to be conceived as a set must be a collection of more than one object. It would be impossible to conceive of Sāmānya if there were not more than one Visesa. He then analyzed the relationship between set and number. In the discussions that followed M. Chakravorty, Bibhuti Bhusan Bhattacharyya and M. D. Srinivas participated.

In his Key-note address on issue no.3, Bibhuti Bhusan Bhattacharyya discussed the validation of any sort of knowledge from the point of view of the Nyaya-Vaisesikas. This is determined by the validity of the instrumental cause of the perception of an object which fulfils the requisition of the perceiver. A thirsty person receives a fluid cool and transparent as water and drinks it. If the object perceived as water quenches his thirst the fulfilment of the requisition of the perceiver validates the instrumental cause of such perception. If mathematical knowledge, being the resultant of the mathematical formula keeping its instrumental cause, yields the requisite number of things enquired, then the formula concerned is valid and in due course the resultant knowledge also becomes valid. Pandit Bhattacharyya further held that Sastric formulas, when applied correctly, should yield correct results provided the terms used are properly understood. He cited a verse from the *Arthaśāstra*, which gives an idea of cost accountancy in Kauṭilya's time, provided the technical terms used, e.g. prakaṣepa, paṇyaniṣpatti, śulka, vṛddhi, abakraya and anyavyaya are correctly understood.

M. D. Srinivas discussed the question of validation of mathematical knowledge from the consideration of proof. Historians of mathematicians generally hold that Indian mathematical tradition, although rich in significant results and processes, failed to present proof of them. Srinivas showed that this view was totally incorrect. Instead of using proof as a method of validation, characteristic of Greek mathematics, the Indian tradition used the method of *Upapatti*, which loosely translated meant justification, derivation, demonstration, validation, and proof. Indian mathematical literature; particularly the commentaries are rich in *Upapattis*. Several examples were given from the texts of the Līlāvatī and the Bījagaṇita, as commented upon by Gaṇeśa Daivajña and Kṛṣṇa Daivajña. As the notion of *Upapatti* in Indian tradition is different from that of proof in the Greek tradition, the real purpose of the former being the same as that of the latter escaped the attention of historians of mathematics.

The issue no. 4 raised the question of relationship between different branches of mathematics. D. K. Sinha upon whom fell the task of leading the discussions on this question recognised that any area of knowledge, that is, discipline, including mathematics, was essentially an aggregate of parts which conditioned the very structure of the discipline. This idea of a discipline consisting of parts is also called 'elementalism'. The same thing is described by another jargon, 'holism', in which parts are linked to the whole. Then in connection with any discipline he introduced the idea of essence and object and the relation between the two. The nature of the two and their relationship, which is specific for mathematics, can be understood only through intuitive thinking. Intuitive thinking, he explained, can be simply stated as a capability to place 'objects' and see their relative importance. In the evolution of mathematics, this intuitive thinking has always played an active part but it has also significantly interacted with logical thinking. In fact, there exists a complementarity between logical thinking and intuition, — a back and forth mobility between the plethora of experiences and spate of abstractions. In his view, each branch of mathematics developed on a particular intuition which endowed it with primitive notions and truths. With the passage of time it acquired a formalized language of its own and built up an entire edifice from one theme, as for example, the theory of sets.

The seminar concluded with a note of satisfaction that it considered in depth some of the important areas of astronomy and mathematics developed in ancient and medieval India and discussed the philosophical implications of these sciences, particularly mathematics. □

S. N. Sen

WHO Collaborating Centre on Drug Information at CDRI, Lucknow

The World Health Organisation has established a "WHO Collaborating Centre on Drug Information" at Central Drug Research Institute, Lucknow. The National Information Centre for Drugs & Pharmaceuticals (NICDAP), a sectoral discipline-oriented Information Centre under the NISSAT Plan of the DSIR, Ministry of Science & Technology, Govt. of India, operating at CDRI since October 1977, has been chosen for this purpose. This Collaborating Centre is the first of its kind established by WHO on Drug Information and the collaboration with WHO has become effective from February 1988 for a period of four years. The Centre will act as a focal point for information activities in the area of drugs & pharmaceuticals for the 11 member-countries of the South East Asian region which include, besides India, Bangladesh, Bhutan, Burma, Indonesia, Democratic Republic of Korea, Maldives, Mongolia, Nepal, Sri Lanka & Thailand. The terms of reference are given below:

(1) To develop and maintain an information base on sources of manufacture of drugs, in-

cluding that on medicinal plant substances and dosage forms, prevailing prices and terms of registration, patent status particularly within the countries of the Region.

(2) Maintenance and updating of comprehensive scientific data on drugs, to support request for bibliographic information from Member States of the Region.

(3) To undertake training of WHO fellows in organisation of drug information system.

The work plan indicates that the Centre will provide information on availability of raw materials required for formulation of essential drugs and their international prices, production technology of some of the essential drugs, therapeutic information on essential drugs, patent laws for new drugs, on registration of the drugs in the countries of this region and training of nationals in drug information system.

The "WHO Collaborating Centre on Drug Information" was formally inaugurated by Dr. Chaiyon K. Sanyakorn, Director, Programme Management, WHO/SEARO, New Delhi on 5 April 1988 at Lucknow. Inaugurating the Centre, Dr. Chaiyon said that the rational use of drugs was crucial for active promotion of Primary Health Care, particularly in the developing countries and this could be achieved by providing appropriate information on drugs. He further added that a large number of drugs were entering into the therapeutic armamentorium of physicians who are unable to keep themselves abreast with their rationale, efficacy, adverse effects, interaction and availability. The need of creation of a data base on different facets of drug information has, therefore, an important role to play in WHO's Action Programme on Essential Drugs, which in turn, will help the World to achieve WHO's motto "Health for All by 2000 AD"

The Centre could be utilised by Member Countries for obtaining information on any particular drug, to enable national authorities to arrive at a decision whether a drug should or should not be registered or marketed in the country. Several developing countries have not as yet established even the mechanisms for registration of drugs, he said. A number of countries in this region are keen on the development of national drug information centers and Dr. Chaiyon added that the scientists at NICDAP could render assistance to them in organising national level drug information centre. The need for such a centre was felt by WHO in view of allegations that the pharmaceutical manufacturers had been dumping drugs & pharmaceuticals of doubtful quality and saftey in the third world countries and not marketing in their own countries. Dr. Chaiyon conveyed his gratefulness to Govt. of India, CSIR & Director, CDRI for this kind gesture of accepting WHO's proposal to establish the Collaborating Centre and to permit the facilities at NICDAP to be utilised by the Member Countries of WHO globally.

A key note address was delivered at the inauguration by Mr. N. V. Satyanarayana, Director, Informatics (India) Pvt. Ltd., Bangalore on the 'Impact of Information Technology on Drugs & Pharmaceuticals Information System' in which he stressed the need to create more and more databases in the field of Drugs & Pharmaceuticals for instant access. He also brought out clearly how, in future, the blending of computerisation, communication and other allied areas will bring the needed information to the researcher's working place in the right package and at the right time.

Dr. M. M. Dhar, Director, CDRI presided over the function. Welcoming the guests, Dr. Dhar pointed out in his presidential address the importance of information in research and thanked the WHO for recognising NICDAP and establishing this Collaborating Centre here. He assured WHO that the Centre will put all its efforts to help the Member Countries in the collaborative activities.

A Union Catalogue of Current Periodicals of LUSLIC (Lucknow Special Libraries Consortium) Libraries has been released on this occassion by Dr. B. N. Dhawan, Scientist-in-Director's Grade, CDRI. He congratulated LUSLIC for bringing out this valuable document which will be a very useful tool for scientists in their research activities. He requested that updating of this Catalogue should be done at regular intervals and added that this will be very easy as the database is computerised. □

The taste of tea

Got a toothache or a stomach disorder ? Then, why not soothe the pain with a cup of lavender or melissa tea. While on the topic of medicinal herbs, if you keep a strict natural diet, try seasoning any one of your meals with organically grown oregano, sage, salvia or thyme. These are some of 30 different local Israeli species grown by David Doron at Mitzpe Hararit, a new community village with 19 families in Galilee's Central highlands.

Doron, an electro-optical engineer formerly employed at Rehovot's Weizmann Institute, settled five years ago with his London-born wife at Hararit—Israel's sole transcendental meditation centre. Having chosen this life-style, biodynamic methods of agriculture neatly fitted in with his quest for balanced and better living. His initial training at Mikve Israel, Israel's first agricultural school near Holon, served him well in his adult transition to farming in Galilee. Immersing himself in his new profession with systematic thoroughness, he started researching carefully local plant life, its climatic conditions, soil requirements and diseases.

"From a dietetic or medical view-point", stresses Doron, "Israeli-grown herbs enjoy a significantly higher quality of fats than herbs grown in other countries around the world. Organic agriculture is intelligent farming", he adds, commenting that he selected the field because of its cerebral challenge and contribution to a healthier society, as well, of course, for its excellent economic prospects.

Unlike classical Sri Lanka, Doron's plantation is a mere one acre plot on a rocky hillside overlooking the scenic beauty of Netufa Valley. Yet Hararit's aromatic herbs and spices make delicious competition even for Earl Grey's prestigious brews. Currently, the plot yields some 3,000 kg of dried and processed herbal leaves. Plants are grown outdoors and organically fertilised. Being perennials, maximum yields are obtained several years after planting. No insecticides or pesticides are applied and plant diseases are controlled through natural selection, by introducing predatory insects to the infected areas. The quality of the herbal blend starts with harvesting. This is done manually, the leaves and stems being hand-picked from only the healthy-plant populations. To keep the herbal blends dry, the leaves and flowers are dried indoors in conditions of low humidity in large mesh wire trays at temperatures of 30-40°C, 5 hr a day for 2-3 days. The blends retain their outdoor freshness and aroma for about a year.

According to Doron, the same herbs that go to make tea and spices can be used for therapeutic purposes as well. He recently, for example, began preparing herbal teas from locally grown red basil, which is said to cure indigestion, nausea and vomiting and hibiscus blossoms and leaves for alleviating antisomatic disorders. A brew of hyssop or thyme leaves soothes nervous tension, depression and anxiety, whereas mint tea is meant to tackle insomnia, dizziness and toothache.

Most of Doron's customers are local visitors at Hararit's transcendental meditation centre, whilst others are tourists who, having heard about the herbal blends, drop in to buy a few packets of his attractively packaged product. Doron's large customers include Israeli natural-health food stores and practitioners of natural medicine.

The Jewish National Fund is to help Doron to improve his herbal farm by granting him money to purchase mechanical harvesters and construct enlarged drying and packaging facilities. The Jewish Agency will prepare extra rocky terrain at Hararit for factory facilities and expand tracts of land for cultivating the herbs. These measures will allow Doron to increase his workforce at harvest stime, which at present consists of two young girls from nearby Kibbutz Avtalyon. His immediate plans are to persuade farming villages and regional councils in the Galilee to organically cultivate extensive tracts of Israeli herbs and to plant them as decorative shrubs in public gardens and parks, reserving him contracted rights to harvest the yields. Savings in production costs and manpower will enable him to develop improved processing methods and more attractive wholesome packaging distribution, locally and abroad. □

News from Israel

Abundance of raw material

A recent study has revealed abundant raw material are readily available in the north-east region of India to be harnessed for setting up agro-based industries there. According to the study, conducted by S. C. Naik of Rourkela Regional Engineering College, prospects are very bright for setting up at least nine agro-based industries like furfural, oxalic acid, active carbon, sodium silicate, water- and fire-resistant briquettes (artificial coal) from agricultural wastes, edible oil from rice bran, agro-based insecticides, besides mushrooms.

Any pentosan-bearing substance formed the main source of the versatile commercial chemical—furfural—usually produced by the steam distillation of raw material in the presence of a catalyst. However, economic considerations bring down the available choice of raw material to a selected few even though production of furfural from coffee husk, rice husk, sawdust and tea husk have been reported. Of these raw materials, rice husk and sawdust are suitable for the region which is rich in them.

The principal uses of furfural are for making derivatives like furans and tetrahydrofurans, as a selective solvent in the refining of lubricating oils, for the manufacture of resins, as an extractive distillation medium in the preparation of butadiene from petroleum and a decolourising agent.

Oxalic acid, a useful organic acid, can be produced from rice husk and sawdust which are treated with nitric acid. The processes is economical in the sense that a less costly acid can be used to oxidise about 50% of the cellulose, giving 49 gm oxalic acid per 100 gm sawdust. Approximately 20% cellulose remains unoxidised to be obtained as residue.

At least 85% of nitric acid is recovered for reuse at the end of the reaction with sodium nitrate obtained as a bye-product. Active carbon, mainly used for decolourisation and absorption of obnoxious gases, besides finding application in any chemical, pharmaceutical and food industries can be manufactured from rice husk also. Sodium silicate widely used in the manufacture of adhesives, detergents, silica gel and soaps is conveniently made by fusing sand and soda ash together at high temperature in a tank furnace and subsequently digesting the fused mass in water.

As the area produces abundant rice husk, the sodium silicate industry will do well here, utilising the recently developed process for its manufacture with rice husk, ash and sodium hydroxide as raw material. The major advantages of the process are that it is simple, involving low-capital investment, its easy adoption by the small sector even in the rural areas, low-fuel consumption and the reaction takes place at a low temperature as compared to the conventional process, besides providing a useful means of disposal for the huge quantities of rice-husk ash.

Prospects are also very bright for setting up water and fire-resistant paper boards, ideal for use in low-cost housing projects, as they are cost-efficient due to their light weight, using the locally available jute sticks and paddy straw. Solid compressed fuel, made out of forest and agricultural wastes, is ideal for the region with its rural and semi-urban areas, offering the raw material a plenty. Unlike dung cake and firewood, fuel briquette is easy to handle, ignite, has low-ash content and only a small volume of smoke.

The region, with abundant rice production, can be an ideal host to rice-bran edible oil mills with batch-solvent capacities as low as 5 tons bran per day. □

The Statesman

New antibiotic defense in animals

A previously unknown chemical defense against infection has been discovered in the skin of frogs. Michael Zasloff, National Institute of Child Health and Human Development (USA), has isolated from frogs two closely related peptides, each 23 amino-acids long, killing a variety of bacteria, fungi and protozoa in test-tube experiments. He discovered these peptides called magainins, after the Hebrew for shield, while investigating why frogs given surgical incisions do not develop infections. The magainins appear to act, at least in protozoa, on ion pumps in the membrane, which disrupt the cell's osmotic regulation. Magainins are the only chemical defense system, distinct from the cellular and humoral immune system, to be found in vertebrates. □

Bioscience

Greenhouse effects

A team of American and British scientists have concluded that weather-pattern changes, predicted by greenhouse-effect models, may already have started appearing. After comparing precipitation reports over major continents since the mid-19th century, researchers noted that over the last 30-40 years there has been a significant increase in rainfall in the mid-latitudes (35°–70°N) and a corresponding decrease in the lower latitudes (5°–35°N), whereas rainfall at the equator has varied little. These changes match those predicted by computer models of warming by the greenhouse effect. Increasing carbon dioxide in the atmosphere and the resultant higher air temperatures may also denote 60–80% worldwide rise in crop yields by the middle of the 21st century, according to a USDA report. Previous estimates of a 30% increase did not consider the effect of higher temperatures on carbon utilisation by crops. □

Bioscience

BOOK REVIEWS

Ribulose Bisphosphate Carboxylase-Oxygenase—edited by R. J. Ellis and J. C. Gray, published by the Royal Society, London, 1986, 165 pages.

This treatise contains 14 chapters written by invited speakers who participated at a meeting arranged by the Royal Society in the December, 1985. In fact, the proceeding of this meeting was published first in Philosophical Transactions of the Royal Society of London, Series B, Volume 313, pages 303-469. An attempt has been made to cover the different aspects of the enzyme Ribulose Bisphosphate Carboxylase-Oxygenase (Rubisco) which catalyses both fixation of CO_2 in the process of photosynthesis and release of CO_2 in the process of photorespiration. This is a key enzyme which takes part in the first step of both photosynthesis and photorespiration. These are, in fact, mutually opposing metabolic processes; the former leads to an increase in carbon content of the organism and the latter to a loss of carbon from the organism. Thus, the balance between photosynthesis and photorespiration controls the overall agricultural productivity and this balance is determined by the intrinsic properties of this enzyme. In the first article, the role of Rubisco in photosynthesis and in the subsequent article its role in photorespiration are reported by D. A. Walker *et al.* and A. J. Keys respectively. Naturally, the next question arises as to how both the activities of the enzyme are regulated. This has been discussed by W. L. Ogren *et al.* Next few lectures are devoted to structural and functional characteristics of Rubisco containing both large and small subunits as well as a binding protein for large subunit. But which was not diseussed is perhaps a protein molecule which regulates the assembly of L_8 and S_8 into an active molecule of Rubisco. Two forms of Rubisco (L_8 and L_8S_8) of almost equivalent Carboxylase and Oxygenase activity have been isolated from different photosynthetic bacteria. It has also been further discussed that a unicellular *Cyanobacterium* evolved to *Cyanelles* which were evolutionary precursors of chloroplasts of both green- and nongreen algae. The latter probably diverged from ancestors of green algae as evidenced by the occurrence of L and S subunit genes for Rubisco in the chloroplast genome of chromophytic algae, *Olisthodiscus luteus.* In contrast, the gene for the S subunit was integrated into the nucleus in the evolution of green algae and higher plants. Structural features of Rubisco have been well discussed. Rubisco is barrel-shaped and has a symmetry. The four-fold axis runsdown an open central channel, concentric with the barrel. The affinity-labelling studies and comparative sequence analyses have identified two different lysine residues at the active site of Rubisco. They occupy positions 166 and 329 in *Rodospirillum* and positions 175 and 334 in spinach enzymes. The carboxylation of RuBP is a unique reaction catalyzed by this enzyme. The overall reaction is at present dissected into five steps. This aspect is very ably discussed by C. H. Lorimer *et al.* The recombinant DNA technique has also been applied to isolate and characterize the gene for two subunits of Rubisco. The small subunit in higher plants is encoded by a nuclear small multigene family. A 33-base pair sequence around the TATA box region has been shown to be involved in light inducibility of this gene. In trangenic *Petunia* plants, it is established that 352 base pairs of 5' upstream sequence is sufficient for light inducibility as well as leaf specific expression. The use of chimeric genes harbouring small subunit transit peptide sequences to study transport in the chloroplasts constitutes another aspect of genetic engineering with the chloroplasts. The cloning of structural genes for subunit of Rubisco has given the prospect of site specific mutation studies to alter the relative rates of the oxygenase and carboxylase activities. The higher plant Rubisco genes can be expressed in *E. coli.* What is needed is to develop a transforming system for the chloroplast though partial claim to use Ti-plasmid for this is encouraging. Definitely success in introducing foreign genes in the chloroplast will constitute future studies and impart an impetus to dissect the chloroplast on molecular basis. The difficulty in keeping up with the progress in this area of research is enormous. Because up-to-date information is lacking in such treatise where information explosion does occur in the case of a Rubisco as well as chloroplasts molecular biology *per se* at a faster rate. However, this treatise is a valuable one and the researchers in this field will have another book as a reference to consult with. ☐

B. B. Biswas

Letters to the editor

Thunderstorms over Guwahati—A case study

Thunderstorm activity over North-eastern region is one of the important problems to be studied in detail. Normally, the damage caused by it is immense. It is a meso-scale phenomenon and as such long range forecasting is not yet possible. Several methods were tried by earlier workers[1-5] to forecast thunderstorms which had some limitations in their usage due to poor communication and data facilities available in this region. Hence, an attempt has been made to find out the applicability of differential thermal advection formula[6] to forecast thunderstorms in this region, especially for Guwahati.

Thermal advection (A) can be written as

$$A = -V.\nabla T \qquad (1)$$

Where V is the wind vector, T is the temperature (degrees absolute) and ∇ is the horizontal differential operator.

The Differential Thermal Advection ($\frac{dA}{dZ}$, here after referred to as DTA) is obtained by differentiating the equation (1)

$$\frac{dA}{dA} = -\frac{dV}{dZ}\cdot\nabla T - V.\nabla\left(\frac{dT}{dZ}\right) \qquad (2)$$

As a first approximation, vertical gradients in the equation (2) can be replaced by difference between 500 mb and 850 mb levels and V and T refer to 700 mb level.. Then equation (2) takes the form

$$\frac{dA}{dZ} = -(V_{500} - V_{850})\cdot\nabla T_{700} - V_{700}\cdot\nabla(T_{500} - T_{850}) \qquad (3)$$

Where T_{700} Temperature at 700 mb level
V_{700} Wind vector at 700 mb level
∇ ( ) horizontal differential operator

DTA values have been computed using equation (3). The horizontal gradients in equation (3) are assumed as difference between two adjacent observations at a single station assuming continuity in the atmosphere.

Upper air observations collected at India Meteorological Centre, Guwahati for three cases of thunderstorms occurred on 8 January, 18 March and 23 April of 1987 were used in this study.

It is proposed that a negative value of DTA is very conductive to severe thunderstorm[6]. Calculated DTA values for Guwahati are represented in Table 1.

TABLE 1 Differential Thermal Advection (DTA) values for three different cases of thunderstorms over Guwahati

	Date	7-1-87	8-1-87	8-1-87	9-1-87
Case	Time	12 GMT	00 GMT	12 GMT	00 GMT
I	DTA	−29.91	−9.67	52.76	−6.03
	Date	16-3-87	17-3-87	17-3-87	18-3-87
Case	Time	12 GMT	00 GMT	12 GMT	00 GMT
II	DTA	5.67	−13.43	−38.95	33.18
	Date	21-4-87	22-4-87	22-4-87	23-4-87
Case	Time	12 GMT	00 GMT	12 GMT	00 GMT
III	DTA	1.53	−3.1	−0.58	21.21

The results showed that the values calculated for 7 (12 GMT) and 8 (00 GMT) January are negative. The storm occurred on 8 January at 14 hr (GMT), 14 hr after a negative DTA value. For 17 March at 00 GMT and 12 GMT, DTA values were observed to be negative and the storm occurred on 18 March at 00 GMT that is 12 hr after the negative value of DTA. Similarly, the calculations for 22 April at 00 GMT and 12 GMT showed negative values of DTA and the storm occurred after 12 hr of negative value of DTA. In all three cases, thunderstorm was observed to occur atleast 12 hr after changing negative DTA value to a positive DTA value. This indicates that DTA could be utilised as a predictor for thunderstorm activity over a 12 hr interval at Guwahati. Positive wind shear between 500 mb and 850 mb levels and steep lapse rate of temperature at 700 mb level contributed to negative values of DTA.

However, detailed studies are in progress, using more number of cases.

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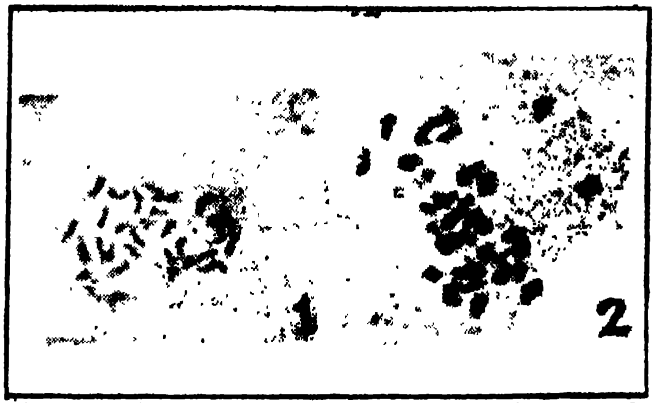
Solanum nigrum complex : Occurrence of triploidy in nature

Members of *Solanum nigrum* L. complex are highly variable phenotypically as well as cytologically and form a polyploid complex based on n = 12. The species are predominantly self-pollinating, but out- and cross-breeding can occur, and natural intra- and inter-specific hybridization, especially with the smaller -flowered diploid, have now been reported[1-3]. In addition, certain species exhibit considerable genetic variation, both florally and vegetatively. The limits of both phenotypic plasticity and genetic variation that are tolerable by different taxa have been assessed from wild population. Genetically variable traits in them have also been recorded in the segregants following artificial hybridization. Crossability studies among the different species of the complex established that the diploid (*Solanum americanum* Mill.) and the tetraploid (*S. villosum* Mill.) species were easily crossable. Natural hybridization between these two has been recorded[4]. It can, therefore, be presumed that they hybridize rather freely in sympatric populations. The present report deals with the occurrence of triploid hybrid plant from a natural habitat with diploid, tetraploid and hexaploid plants.

The hybrid plant is vigorous with abundant flowers but no fruit on it. The sterility of triploids will reasonably account for the absence of fruits[5]. The triploid plant is fully pollen-sterile. Gray[6] and Henderson[3] reported that large number of collapsed, unstained pollen grains are usually indicative of hybrid origin of any plant of this complex. Cytology of the hybrid plant confirmed its triploid nature (Fig.1). Diakinesis and metaphase I revealed univalents, bivalents and trivalents with various frequencies (Fig. 2). Chromosome association at metaphase I, was $7.80_{I} + 11.40_{II} + 1.80_{III}$. Chromosome irregularities of the triploid included frequent laggards and chromatin bridges. Chromosome were also disposed in five or more groups instead of four at telophase II indicating structural differences between parental genomes. It has been assumed, on the basis of meiotic studies, that the triploid originated from the diploid *S. americanum* x the tetraploid *S. villosum* after natural hybridization. It is further assumed that the widely occurring hexaploid form has evolved from spontaneous doubling of chromosomes of such triploid plants[7].



Figs. 1–2: (1) Somatic chromosomes 2n = 36; (2) Metaphase I showing $9_{I} + 9_{II} + 3_{III}$ in triploid x 1500

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Richardia scabra L.—A new record for West Bengal

An angiosperm collected from Liluah of Howrah District, West Bengal turned out as a new report for the state following its identification on the basis of available literatures, specimens at the Central National Herbarium, Shibpur and a thorough scrutiny of floristic work on West Bengal as enumerated in 1973 by Basak[1] and mostly those appearing later on[2-11]. This specimen is preserved in the Herbarium of Maulana Azad College, Calcutta.

The salient features of the plant is registered to facilitate easy identification with notes on its common synonyms, occurrence and economic use[12].

Richardia scabra L. Sp. P1. 330. 1753. (Rubiaceae)
R. brasiliensis Gomez, Mem. Ipecac 31. 1801.
R. pilosa Ruiz. et Pav. Fl. Peru. 3:50, t. 279 b. 1802.
Richardsonia pilosa (Ruiz. et Pav.) H.B.K. Nov. Gen. Sp. 3:350. 1820.

Plant a prostrate, annual, densely pilose herb; stem quadrangular with characteristic divergent branching. *Leaves* sub-sessile, elliptic to oblong, narrowed at the base. *Stipules* connate into a cup with setaceous appendages. *Flowers* in terminal congested capitate clusters subtended by 2-4 involucral foliose bracts, hexamerous, sessile, white.

Stamens 6-8. *Ovary* 3-celled, densely papillose with persistent calyx.

Seed one in each cell, hispidulous.

Flowering and *Fruiting* : November - May.

Field notes : A prostrate herb, somewhat ascending, occurring in and around railway tracks.

Distribution : Pantropical, a native to South America. This was first introduced in Shillong and now it has been reported from other parts of Meghalaya, Andhra Pradesh and Uttar Pradesh.

Economic use : It is used as hay or for pasturage. This plant, commonly known as 'undulated or false Ipecac', is a substitute or adulterant of true Ipecac.

Specimens examined : Anantagiri, Visakhapatnam Dt., Andhra Pradesh, alt. c. 900 m, N. P. Balakrishnan 819 (CAL), Liluah, Howrah Dt., West Bengal. 27.5.87; Mukherjee & Namhata 1020.

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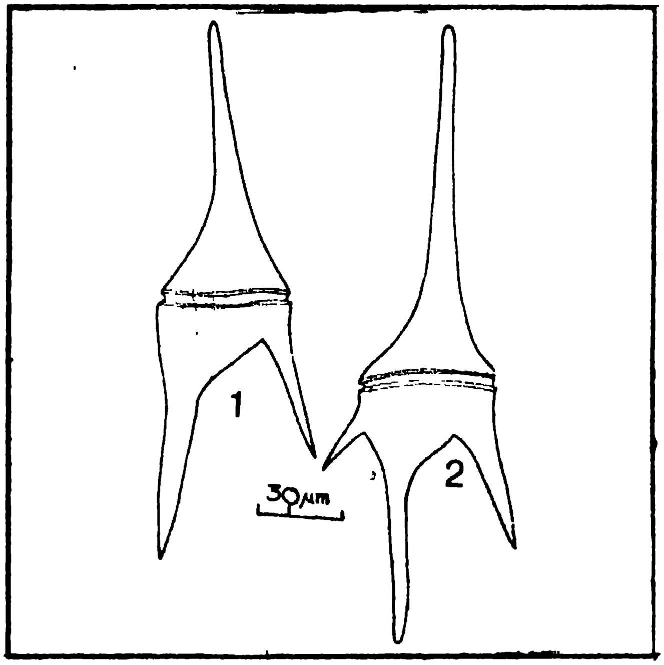
Addition of two dinoflagellates to Indian freshwater algal flora

The members of dinoflagellatae are mostly recorded from marine and brackish water[1,4]. *Ceratium* is a well-known genus of this class. The species of *Ceratium* cause waterblooms[1, 4-6] that appear for shorter periods and are considered as indicators of water quality. Although their roll in freshwater habitats is not known, some worker have reported that most of the taxa secrete certain toxic substances which affect the population of fishes and molluscs[5,6]. During the course of investigation on the freshwater algal flora of Bareilly and its environs, the authors came across two species of *Ceratium*, viz. *C. furca* (Ehr.) Claparede & Lackmann and *C. hirudinella* (O. F. Muller) Bergh., which also happen to be first records of freshwater dinoflagellates from India. Both species were collected from Ramganga river (Bareilly), Uttar Pradesh during March-April 1987.



Figs. 1-2: (1) *Ceratium furca* (Ehr) Claparede and Lackmann. (2) *Ceratium hirundinella* (O. F. Muller) Bergh.

Ceratium furca (Ehr.) Claparede and Lackmann. (Fig.1).

A medium-sized species epitheca narrowing rapidly apical horn longer than broad, drawn out into a long apical tube; antapical parallel, both more or less pointed, frequently toothed; epitheca 92-98 µm long, girdle 47-50 um broad; cells150-185 µm long.

The present form resembles the type but for the length i.e. Cells are longer than the type (151.3-157.8 µm).

Distribution : Australia[2], Kamafuli[7] and Bay of Bengal[3].

Ceratium hirundinella (O. F. Muller) Bergh. (Fig. 2).

Cells dorsiventrally flattened, epitheca long and becomes gradually narrower; hypotheca broad with three hind horns differentiated in size and direction; epitheca 120-126 µm, long girdle 48-49 µm broad cells 210-220 µm long.

The length of cells of present taxa is more than the type (165.3-176.7 µm).

Distribution : This a very common from especially in hard-water lakes[4], North Europe[9], North Asia[8], Karnafuli[7], Great lakes area, America[4] and Bay of Bengal[3].

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Effect of cultural factors on crude protein production by *Sclerotium rolfsii*

Rice straw is a major agricultural by-product in the tropical countries and is mainly used as cattle feed. The digestibility of rice straw in ruminant in only about 30 per cent due to its high lignin, silica contents and the crystalline structure of its cellulose. Therefore, rice straw must be either processed or supplemented to overcome these limitations before it can be used as animal feed[1].

Fermentation of cellulosic materials for production of protein using bacteria, yeast and fungi has been reported by a number of workers[2-5].

The present paper presents the results on the effect of the some variables on the protein production by *Sclerotium rolfsii* from rice straw.

Sclerotium rolfsii was isolated in our laboratory by soil enrichment technique[6] and identified by the Division of Mycology and Plant Pathology of our Institute. The culture was maintained on potato dextrose agar slants stored at 4°C and sub-cultured once a month.

Glucose-yeast extract broth[7] was inoculated with a few bits of an actively growing culture and incubated at 28 ± 1°C on a rotary shaker (120 rpm). The 3-5 day old mycelium along with broth was homogenized in a pre-sterilized blender at high speed for 30 sec.

The rice straw was soaked in lN NaOH in the ratio of 20:1 (w/v) and autoclaved at 15 psi for 30 min. The material was washed free of alkali and ground to mesh-size of 16.

The culture was grown in 50 ml of a basal medium[8], taken in a 250 ml Erlenmeyer flask, containing 0.5 g substrate (sterilized at 121°C for 20 min.). The flasks were inoculated with 2.0 ml of the inoculum and incubated at 28 ± 1°C on a rotary shaker for 7 days and harvested by filtration through filter paper Whatman No. 1 and washed. Then the produce was dried as 60°C, weighed and used for estimation of total nitrogen.

Crude protein was estimated from the total nitrogen (micro-kjeldahl) and multiplying the value by a factor of 6.25. Protein recovery (mg/g straw) calculated as follows :

% crude protein x wt. of unutilized substrate plus mycelium x 2.

Higher crude protein of 18.51 per cent and protein recovery of 102 mg/g of alkali treated rice straw (AT rice straw) was obtained in continuously shaken culture as compared to stationary and intermittent shaking. The favourable effect of shaking on protein production has been reported[2, 3] Most of the studies have been carried out in shake culture or fermenter except solid state cultivation for production of fungal cell mass. However, more than double the cultivation time was required for solid state cultivation as compared to stirred tank reactor[9].

The effect of different levels of aeration was studied by varying the volume of growth medium in flask. It was noticed that maximum crude protein (18.81%) and protein recovery (106 mg/g of substrate) was obtained with 50 ml broth and thereafter it decreased with increasing volume of the medium. Thus extent of aeration affected the growth of the organism which in turn influenced the crude protein content.

The effect of size of inoculum on protein production by *S. rolfsii* showed a positive correlation among the crude protein content, the protein recovery and size of inoculum upto a certain limit and thereafter no significant increase in crude protein was obtained. Five per cent inoculum was found to be optimum. Similar results were reported with *Aspergillus terreus* using alkali treated bagasse.

The effect of initial hydrogen ion concentration of growth medium on the growth of *S. rolfsii* with AT rice straw showed that maximum crude protein (21.3%) and protein recovery (116 mg/g of substrate) was attained at pH 4.5. The optimum pH for organism varied from one organism to another viz. pH 4.5 for *Cochlibolus* specifer[10], pH 4.0 for *Aspergillus terreus*[2], and pH 4.0 for another strain of *A. terreus*[3].

The effect of incubation temperature on protein production was obtained at 30°C. However, there was difference in protein content when the temperature was decreased to 25°C and increased to 35°C.

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Effect of pre-sowing treatment of mustard seeds with leaf- and inflorescence-extracts of *Chenopodium ambrosioides*

Chenopodium ambrosioides Linn. is a tall strongly aromatic glandular herb bearing oblong-lanceolate leaves, flowers in simple or panicled spikes and obtuse seeds. A native of Mexico, it is a recently introduced weed in India and found in moist undisturbed waste places along roadsides and near gardens[1] This species is distributed in Kashmir, Central Panjab, Bihar, Maharashtra, the Deccan and Western Ghats up to 7,000 ft above sea level[2,3] in addition of West Bengal. The plant was used medicinally by the American Indians in the days of Columbus and seeds have been used as a household remedy against intestinal parasites[4].

As a noxious weed, *C. ambrosioides* flowers from April to September in the vicinity of Calcutta. It emits a vigorous camphoraceous odour and excludes other species in its habitat. Anything which prevents a seed from sprouting and discourages a species from thriving must have a powerful influence on the constitution of the plant community[5]. This could perhaps indicate an allelopathic effect and led to a comprehensive study, revealing the presence of germination and growth inhibitors in *C. ambrosioides*[6]. The present communication embodies the results from studies on the effects of pre-sowing treatment with two extracts of *C. ambrosioides* on vegetative and reproductive phases of mustard (*Brassica campestris* L. var. *dichotoma* Watt.).

Actively growing plants of *C. ambrosioides* were collected during 1976-78. Leaf and inflorescence from each species was separated. Extracts were prepared by crushing 100 gm plant tissues in a Bajaj mixer with glass-distilled water. Each type of extract was filtered through Whatman (No. 1) filter paper and filtrate brought to 250 ml with additions of water. Each filtrate formed the standard plant extract (1:2.5) from which other concentrations like 1:5, 1:10 and 1:20 were made by way of dilution.

Before sowing, 50 surface-sterilized (2% sodium hypochlorite for 10 min.) mustard seeds were soaked in various concentrations of both leaf- and inflorescence-extracts for 12 hr. Seeds were then sown in Petri-dishes (11 cm diam.) and flower pots 30 cm diam.), using loamy garden soil in each case. While germination counts were taken from seeds in dishes, seedlings appearing in pots were thinned down to 10 per pot and allowed to grow to maturity. From these mature plants, plant height, number of branches, fruits and seeds as well as seed weight were recorded. These data were subjected to statistical analysis and the levels of significance determined.

Mustard seeds, pretreated with 1:2.5, 1:5 and 1:10 concentration of the leaf-extract, produced significant reductions in germination when set on Petri-dishes rather than on soil where only 1:2.5 concentration was inhibitory (Table 1). In this connection, 1:2.5 and 1:10 concentrations were more inhibitory in Petri-dishes. There was no sharp drop in height and branch number of plants arising from the pre-treated seeds. A decline in fruit output was evident in plants derived from seeds soaked in maximum concentration (1:2.5) of the leaf-extract. No significant lowering of seed output was recorded in plants originating from pre-soaked seeds. A significant decrease in seed weight was obtained from plants after pre-soaking in maximum concentration of the leaf extract, whereas an increase in seed weight was noted after treatment with 1:5 concentration.

TABLE 1 : Growth parameters of mustard as influenced by soaking of seeds in leaf and inflorescence-extract of *C. ambrosioides* for 12 hr

Growth parameter		Control	Leaf				Inflorescence			
			1:2.5	1:5	1:10	1:20	1:2.5	1:5	1:10	1:20
Germination (%)[a]	Petridish	98.0	77.0	85.0	94.0	98.5	57.0	78.0	91.0	96.0
		±0.82	±3.42**	±1.29**	±0.82**	±0.96	±2.65**	±3.16**	±2.65*	±2.16
	Pot	98.5	92.0	96.0	98.0	99.5	75.0	85.5	93.0	99.0
		±0.96	±0.82**	±0.72	±0.82	±0.50	±3.11**	±1.71**	±1.29*	±0.58
Plant height[b]		64.2	63.2	66.9	65.3	67.9	62.5	61.3	63.6	65.4
		±2.80	±2.40	±3.54	±1.06	±2.22	±2.97	±1.83	±1.52	±1.24
Number of branches/plant[c]		4.60	3.80	5.00	3.70	4.00	3.30	3.40	3.60	4.20
		±0.48	±0.44	±0.65	±0.56	±0.61	±0.63	±0.65	±0.30	±0.79
Number of fruits/plant[d]		53.3	38.0	56.1	50.9	56.5	34.1	34.8	34.7	40.9
		±4.21	±4.31	±9.90	±4.07	±7.68	±3.66**	±4.01**	±4.12**	±5.87
Number of seeds/fruit[e]		14.5	14.3	16.5	15.3	15.2	14.3	16.1	15.1	15.4
		±0.85	±0.70	±0.95	±0.84	±0.74	±1.19	±0.82	±0.99	±0.93
Weight of 100 seeds (gm)[f]		0.170	0.159	0.211	0.167	0.171	0.152	0.154	0.153	0.157
		±0.003	±0.001**	±0.004**	±0.002	±0.003	±0.002**	±0.009**	±0.001**	±0.002**

a = Average of 4 replications; b, c, d = Average of 10 plants; e = Average of 15 fruits;
f = Average of 10 replication of 100 seeds
* Significant at P = 0.05; ** Significant at P = 0.01

Seeds, pre-soaked with 1:2.5, 1:5 and 1:10 concentrations of the inflorescence extract, showed a significant drop in germination values when set on Petri-dishes and potted soil (Table 1). Here also 1:2.5 and 1:5 concentrations were more inhibitory than 1:10. No significant difference in plant height or branch number were induced by pre-sowing seed treatment with the inflorescence-extract. A decrease in fruit output was evident in plants which arose from seeds soaked in the three higher concentrations of the inflorescence-extract. There was no reduction in the number of seeds per fruit by pre-soaking. A remarkable fall in seed weight was obtained from plants derived from seeds soaked in all concentrations of the inflorescence-extract. Sugha[7] observed that soaking of pea (*Pisum sativum*) seeds in the tuber-extract of superb lily (*Gloriosa superba*) had stimulatory effects on growth characters and the long-duration soaking inhibited the germination and seedling growth of pea. In the present case, the duration of pre-soaking had not been studied and the effect of various concentrations at a single pre-soaking had been pursued. It was quite possible that leaf- and inflorescence-extract of *C. ambrosioides* contained inhibitor(s) which acted as an deterrent not only to seed germination and seedling growth but also to more mature phases of plant growth and development. This was also true for the leaf- and inflorescence-extracts of the non-aromatic species of *Chenopodium*, *C. murale*[8]. However, the reduction in inhibitory activity was such that it could be strikingly detected by the highest concentration of leaf- and inflorescence-extracts of each species.

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Umbelliferone in rooting of mungbean cuttings

Umbelliferone (UM) is considered as the true parent of nearly all the naturally occurring coumarins[1]. Coumarins are converted to UM by some soil microgranisms[2], but the process in not yet detected in higher plants. Promotion of rooting by coumarin has been reported[3]. This paper reports the effect of UM on root formation in mungbean cuttings.

Mungbean seedlings were raised on a seed tray (25 x 20 x 4 cm) over a vermiculite media under worm white fluorescent tubes at 700 lm ft^{-2} in a 16-h photoperiod and 25°C temperature. Initially the trays were covered with glass sheet for 3 days after saturation with water. The seedlings were ready on the fifth day of sowing when the leaves were not fully expanded. Uniform seedlings were selected and the hypocotyl cut with a razor blade 40 mm below the cotyledonary node. The cotyledons were removed by hand and four cuttings were placed in a 5 ml vial, containing 4 ml of test solution. Umbelliferone (7-Hydroxy-2H-1-benzopyran-2-one; 7-Hydroxycoumarin) was collected from M/S Sigma Chemical Company Ltd., U. S. A. and the test solutions were made by dissolving it in glass distilled water. Five vials were used for each treatment. The cuttings were placed under the same condition as described for raising of seedlings. The roots protruding from cuttings were counted 7 days after immersion. The experiment was repeated 6 times.

TABLE 1 : Effect of umbelliferone on rooting in mungbean cuttings

Treatment						Number of roots[a]
days	0-1	1-2	2-3	3-4	4-6	
Umbelliferone 50 ng/ml	H_2O	H_2O	H_2O	H_2O	H_2O	11.2 ± 1.01
	UM	H_2O	H_2O	H_2O	H_2O	18.3 ± 2.11
	UM	UM	H_2O	H_2O	H_2O	21.4 ± 2.13
	UM	UM	UM	H_2O	H_2O	22.6 ± 4.11
	UM	UM	UM	UM	H_2O	17.8 ± 3.10
	UM	UM	UM	UM	UM	17.2 ± 2.89
	H_2O	UM	UM	UM	UM	13.3 ± 2.13
	H_2O	H_2O	UM	UM	UM	13.2 ± 2.28
Umbelliferone 25 ng/ml	H_2O	H_2O	H_2O	H_2O	H_2O	10.9 ± 2.13
	UM	H_2O	H_2O	H_2O	H_2O	12.7 ± 1.89
	UM	UM	H_2O	H_2O	H_2O	13.6 ± 2.22
	UM	UM	UM	H_2O	H_2O	13.8 ± 2.16
	UM	UM	UM	UM	H_2O	13.2 ± 2.12
	UM	UM	UM	UM	UM	11.9 ± 1.78
	H_2O	UM	UM	UM	UM	11.9 ± 2.08
	H_2O	H_2O	UM	UM	UM	11.9 ± 2.08

a. Mean of 60 cuttings and standard error of the mean

UM has root promoting activity and at 50 ng/ml it increased rooting by 19-102% compared to 9-27% at 25 ng/ml (Table 1). At 50 ng/ml treatment for one day, rooting increased by 92% but in 2 days treatment the same concentration enhanced it by 102%. The present results show that, in mungbean cuttings UM is a rooting stimulator and treatment with 50 ng/ml for 1 day has been proved to be sufficient. The effect of UM on rooting has shown two different effects, viz., a root promoting and a root inhibitory effects which are dependent on the concentration of UM as well as duration of treatment. The inhibitory effect of UM on rooting was earlier reported in *Phaseolus vulgaris* cuttings[4].

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Thermostability of extracellular amylase of Meso- and Thermophilic fungi

Thermostable amylases are variously used in brewing, textile and pharmaceutical industries[1]. However, extracellular amylases secreted by thermophilic fungi have been reported as heat stable[2]. Moreover, thermophilic bacteria and actinomycetes have been used for the production of thermostable amylase[3].

With this prospects the present investigation has been designed to study the thermostability of amylase produced by mesophilic (*Paecilomyces variotii*) and thermophilic (*Humicola grisea*) fungi.

Humicola grisea and *P. variotii* were isolated from wheat straw compost and garden soil respectively. Both the fungi were screened on the yeast powder soluble starch (Ypss) agar plates using Lugol's iodine on the basis of clearing zone at 40°C and 30°C respectively.

Erlenmeyer flasks containing 60 ml of starch yeast extract (SYE) broth (0.5% soluble starch, yeast extract, 2 g/1, K_2HPO_4 1g/1, $MgSO_4.7H_2O$, 0.5 g/1, pH 6.8) were autoclaved (15 lb p.s.i. pressure for 1 h). The flasks were inoculated separately with an agar block (5 mm) cut from actively growing margin of *H. grisea* and *P. variotii*, incubated at 45°C and 30°C respectively. The hyphal mat was filtered after 6 days through Whatman No.1 filter paper. The amylase activity of the filtrate was determined quantitatively by using DNS (Dinitrosalcilic acid) reagent[4] at 20°C, 25°C, 30°C, 35°C, 40°C, 45°C, 50°C, 55°C, 60°C, 70°C, 80°C, 90°C respectively. The enzyme activity was expressed as Unit enzyme in 1 ml of filtrate releasing 1 mg of reducing sugar from 1% starch solution in 1 h at 45°C at pH 6.9.

It is evident from Table 1 that *H. grisea* did not produce amylase at 20°C, its activity gradually increased with increasing the temperature upto 45 °C. *H. grisea* displayed maximum amylase activity (4.2 mg/ml) at 45-50°C, which declined slowly from 50 to 90°C and persisted at 90°C for a period of one hour. The mycelial dry weight of *H. grisea* at 45°C after 6 days of incubation was 134.0 mg/60 ml.

TABLE 1 : **Thermostability of amylase of *H. grisea* and *P. variotii***

H. grisea		*P. variotii*	
Temperature (°C)	Enzyme unit (mg/ml)*	Temperature (°C)	Enzyme unit (mg/ml)*
20	0	20	1.4
25	1.1	25	2.5
30	1.9	30	3.7
35	2.8	35	4.0
40	3.8	40	2.9
45	4.2	45	1.0
50	4.1	50	0.8
55	3.7	55	0.3
60	3.5		
70	3.2		
80	3.0		
90	2.5		

*Reducing sugar mg/ml

The amylase activity of *P. variotii* was maximum (4.0 mg/ml) at 35°C but above 35°C, activity declined sharply upto 45°C and thereafter, gradually declined upto 55°C. The amylase of *H. grisea* was more thermostable than that of *P. variotii*. Thermostability of amylase producing strains could be due to their genetic adaptibility to carry out their biological activities at higher temperature.

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Settling and feeding response of brown planthopper, *Nilaparvata lugens* Stal on some newly evolved rice cultivars of Orissa

Host selection by phytophagous insects is a chain reaction of behavioural and physiological processes (plant stimuli-insect response) in which each event facilitates the unfolding of the next one[1]. BPH feeding activity studies is one of the assay methods to differentiate the degree of resistance/susceptibility among the rice cultures and to identify BPH biotypes[2]

In the Entomology Department of the Orissa University of Agriculture and Technology (OUAT), Bhubaneswar settling and feeding response of BPH on 6 rice cultivars were studied. In a choice test, 100 newly emerged brachypterous females mildly immobilized by CO_2 were released in the centre of a clay pot having 45-day old seedlings of test cultures planted randomly in a circle. Plants and insects were caged in a mylar cage. Insects settled on respective cultivars at 12, 24 and 36 hr post-release period were counted. For feeding response test, another replicated experiment was conducted in which a single 45-day old seedling of each of the test cultivar was grown in clay pots. Bromocresol green-treated filter paper (2 mg/ml ethanol) was placed on the soil top. The basal region of each seedling was housed in an inverted transparent plastic cup (feeding cage) in which 3 pre-disposed brachypterous females (3-day old) were introduced. Honey/dew excretion of BPH on coming into contact with filter paper developed into bluish green spots. The spread of the spots was proportional to the quantity of honey dew excreted.

Significantly greater number of hoppers settled on *Jaya* during 12-36 hr period as compared to *Daya* and *Pratap* (evolved by OUAT) *Sinna Sivappu* and *IET 7575* followed by *Utri Rajapan.* Honey dew excretion, which had a bearing on the quantity of food ingested, was the maximum in *Jaya* followed by *Utri Rajapan* and *Daya*. BPH had the least feeding preference for *Pratap, Sinna Sivappu* and *IET 7575*. According to the above response the cultivars were graded as susceptible (*Jaya*), resistant (*Daya, Pratap, Sinna Sivappu, IET 7575*) and tolerant (*Utri Rajapan*) (Table 1).

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TABLE 1 : Settling and feeding response of BPH on 6 rice cultivars at Bhubaneswar (India)

Cultivar	Cross	Insects settled (%) h after release*			Area of honeydew spread** (mm^2)
		12	24	36	
Susceptible check					
Jaya	TN 1 x T 141	26a	36a	46a	236a
Resistant					
Daya	Kumar x CR 57-49	8c	6c	5c	98b
Pratap	Kumar x CR 57-49	8c	6c	4c	62b
Sinna Sivappu	Sri Lankan Cv.	4c	3d	1d	60b
IET 7575	Sona x Manoharsali	17bc	9c	7c	72b
Tolerant					
Utri Rajapan	Indonesian Cv.	20ab	19b	16b	216a

* Av. of 3 replications

** Av. of 4 replications

In a column means followed by a common letter are not significantly different at $P = 0.05$ by DMRT (Duncan's Multiple Range Test).

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Studies on the biology of *Homoeosoma* sp. (Lepidoptera : Phycitidae) a bud borer of *Ixora singaporensis*

Ixora spp. are perennial evergreen flowering shrubs widely grown in lawns and gardens for their ornamental value. Perusal of literature reveals that no record of pests on these important ornamental plants. During the course of observation, the bud borer *Homoeosoma* sp. was noticed to feed and cause considerable damage to the flower buds during August-September 1985 in the campus gardens of University of Agricultural Sciences, Dharwad. Reports are available with regard to *H. ellectellum* on Sunflower seed heads causing extensive damage from Oregon[1], Canada[2] and 'South Georgea[3]. Since no information is available on the biology of *Homoeosoma*, which is a new report on *Ixora* spp. an attempt has been made to study the biology of this pest on *I. singaporensis*.

The experiment was conducted in the laboratory at temperature ranging from 21 to 29°C and 31 to 60 per cent relative humidity. A known number of *Homoeosoma* sp. adult pairs from laboratory culture were released in insect cages with the host inflorescence. Eggs laid on each day were collected with a wet camel hair brush and 50 eggs were kept for hatching. Immediately after hatching, the larvae were transferred on to fresh *I. Singaporensis* buds maintained in 3 replicates in petri-plates of 5 cm diametre provided with wet blotting paper at the base to maintain the required humidity. The feeding material was renewed daily in the morning, until the larvae pupated. Data on the egg, larval, pupal period, fecundity and nature of damage were recorded.

Mating took place after moth emergence during cool hours. Before copulation, the male moths were active and excited, while the females were passive. The moths mated end to end more than once during their life. The mating period lasted from 1 to 5 minutes between 8 to 10 pm and 5 to 6 am on the next day of emergence. Eggs were laid individually within few hours, after pairing, on the flower buds, corolla or sepals. The oviposition period ranged from 3.00 ± 0.61 days to 4.12 ± 0.11 days.

Egg : Freshly laid eggs were transparent, turned to dirty white towards hatching. Then were globular, measuring 0.66 ± 0.01 mm with a flat bottom. The eggs hatch during cool hours with an incubation period of 5.00 ± 0.00 days.

Larva : The newly hatched larva selected a suitable place, fed by scrapping the soft surface of corolla and bored into the flower bud. As the larva reaches the last stage, they fed voraciously on petals, constructing galleries out of fine silken material and excreta (Fig. 1). In severe cases of damage, the whole flower bunch gets skeletanised. The larvae occationally attacked the vegetative buds and young leaves. In nature, bored buds failed to develop or bloomed with tiny holes. There were five instars with a larval period

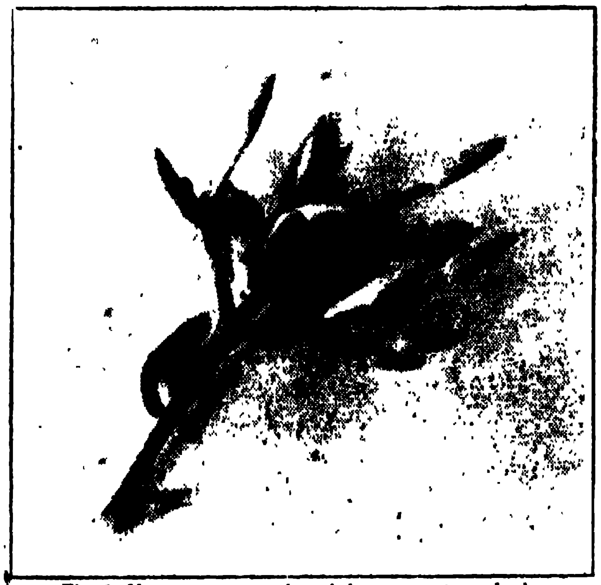

Fig. 1. *Homoeosoma* sp. larval damage to *Ixora* buds.

TABLE 1 : Development of *Homoeosoma* sp. on *Ixora singaporensis* (Number observed 20)

Stages of development	Duration (Days)
Incubation	5.00 ± 0.00
Larva	
First instar	2.60 ± 0.44
Second instar	2.80 ± 0.40
Third instar	2.60 ± 0.44
Fourth instar	2.50 ± 0.50
Fifth instar	3.60 ± 0.71
Total larval development	14.08 ± 0.24
Pupa	10.79 ± 0.65
Total development Period	29.80 ± 0.84
Longevity	
— Female	6.30 ± 1.23
— Male	5.33 ± 0.44
Fecundity	20.50 ± 6.02

of 14.08 ± 0.24 days (Table 1). The extent of damage to the flower buds during August-September, varied from 14.00 to 45.12 per cent.

First instar : The body of newly hatched larva was pale white, turn to pale yellow after 24 hours. The first instar larva measured 3.44 ± 0.27 mm in length and lasted 2.60 ± 0.44 days.

Second instar : The second instar larvae measured 4.25 ± 0.27 mm in length, had pale red body covered by setae. The instar lasted for 2.80 ± 0.40 days.

Third instar : The larva measured 4.69 ± 0.20 mm in length, became crimsoned with distinct long setae, lasted for 2.60 ± 0.44 days.

Fourth instar : The larva was dark red with conspicuous setae, lasted for 2.50 ± 0.50 days, measured 5.75 ± 0.53 mm in length.

Fifth instar : The larva was similar to the fourth instar, measured 6.97 ± 0.11 mm in length and occupied 3.60 ± 0.71 days. At this stage, larvae wriggled when disturbed.

Pupa : In the laboratory, pupating caterpillars constructed fine silken cocoon, within which pupation took place and the color gradually changed to brown as the age progressed. The pupa measured 6.30 ± 0.19 mm in length. The pupal period lasted for 10.79 ± 0.65 days. The total developmental period lasted for 29.80 ± 0.84 days.

Adults : *Homoeosoma* sp. is a delicate straw colored moth with dark brown forewings and light straw colored hind wings. The females were bigger with 6.33 ± 0.20 mm wing expanse, lived for 6.30 ± 1.23 days. The males were comparatively smaller with a wing expanse of 6.11 ± 0.52 mm and lived for 5.33 ± 0.44 days. Fecundity ranged from 10 to 29, with an average of 20.50 ± 6.02 eggs (Table 1).

Host range : In addition to *I. singaporensis*, the pest was also observed to feed and breed on *Ixora bandhuca* Roxb., *I. chinensis* Lam., *I. duffii* Moore, *I. flava*, *I. macrothrysa* T. & B. and *I. parviflora* Vahl., which are grown in the college campus and Botanical Gardens of Karnataka University, Dharwad.

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A new disease of *Gossypium arboreum*

Karunkanni Cotton, *Gossypium arboreum* L. is a widely cultivated fibre crop in many parts of Tamil Nadu. During July-August 1987, the incidence of crown gall was noticed in isolated patches at the University Farm, Coimbatore. The affected plants exhibited stunting and yellowing of leaves. Forty-five day-old plants were severely affected and seldom produced flowers. The pathogen produced yellowish brown galls at the crown region below the soil level. The gall was irregular in shape, 6-10 x 4-7 cm in size (Fig. 1). Microscopic examination of the gall tissue revealed parenchymatous cells having no fungal hyphae or spores, but containing profuse bacteria.

The pathogen was isolated in pure culture in lactose yeast-extract medium. The morphological, cultural and biochemical characters of the pathogen were examined by standard methods[1]. The bacterium is gram negative, rod-shaped; non-spore forming; measuring 2.6–3.2 μ x 0.2 μ; utilises glucose and produces acid; positive for indole and produces no gas in peptone broth. Glucose, fructose, sucrose, manitol and lactose are utilised as carbon sources. The bacterium resembles the one described by Gibbs and Shapton[2] and identified as *Agrobacterium tumefaciens* (Smith and Townsend) Conn. The pathogenicity was proved by Koch's postulates. A bacterial suspension (10^7 cfu/ml) injected at the collar region of 30 day-old Karunkanni cotton plants raised in pots containing sterile soil produced typical crown-gall symptom

Fig. 1. Plants showing gall symptom

after 35 days of inoculation. This is a new report of the organism causing crown-gall disease on cotton.

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Alternaria blossom blight of Chrysanthemum

Chrysanthemum (*Chrysanthemum indicum* L.) is an important ornamental cultivated in many parts of India for its flowers. Incidence of a severe blossom blight has been consistently observed during the monsoon months in the experimental farm of the Institute and in growers fields. The disease was more serious in the cultivars 'Local Yellow' and 'Flirt'. On young buds infection is first seen as small black spots which soon enlarge. The infected buds shrivel, turn brown and drop prematurely. This 'bud blast' symptom develops rapidly especially in moist warm weather. In open flowers, the ray florets first show small brown to black spots which also soon enlarge so that the blooms become deformed and shrivelled. The ray florets become short, narrow and incurved and their number is reduced (Fig. 1). Sometimes partially opened flowers are infected and the individual florets turn brown and shrivel.

Occasionally small circular to irregular necrotic spots appear on the foliag These spots coalesce and enlarge resulting in withering and defoliation of leaves.

The pathogen was isolated from infected flower buds, florets and leaves on potato dextrose agar (PDA) and later purified by single conidial transfer. On PDA, colonies were effuse, hairy, grey to dark black with branched, pale olivaceous brown hyphae.

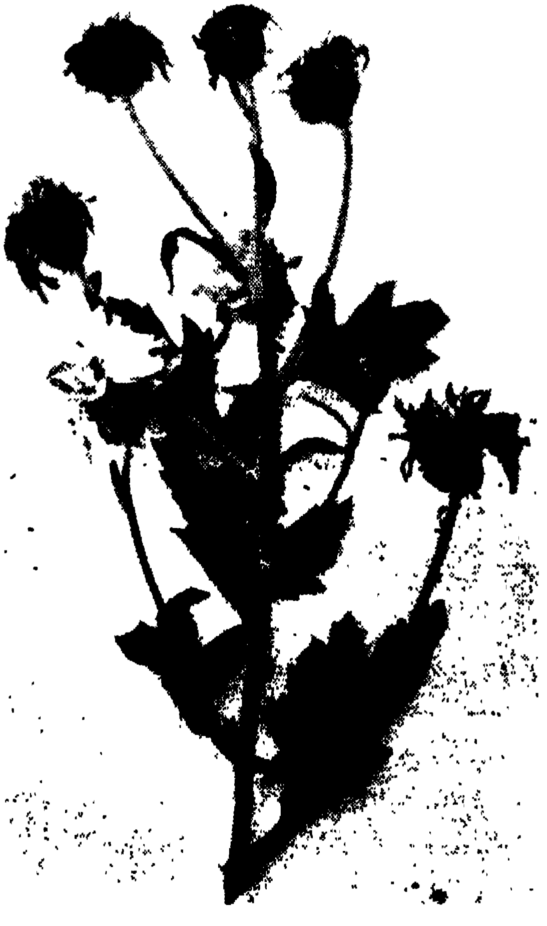

Fig. 1. Infection symptoms on young buds and partially opened flowers

Conidiophores (56-150 µm long, 2.5-6.25 µm wide (av. 88.50 x 5 µm) arose in groups of 2-6, they were simple or occasionally branched, straight or flexuous, septate, pale to mid olivaceous or golden brown and bore solitary conidia. Conidia were obclavate to ellipsoidal, 37.5-75 x 10-15 um (av. 51.87 x 13.12 µm) pale to mid-golden brown, smooth with a short pale conical or cylindrical beak which did not extend more than one third the length of conidium. There were two to five transverse septa with two or more oblique longitudial septa.

Pathogenicity was tested by spraying young buds, freshly opened flowers and also leaves of susceptible cultivars with conidial suspension. Typical symptoms developed 7-10 days after inoculation. Cultures obtained by reisolation from induced lesions were identical with the original isolate. Control sets remained healthy. Morphology and other diagnostic characters indicated that the pathogen was *Alternaria tenuis* Auct (= *A. alternata* (Fr.) Keissler). A subculture of the fungus has been deposited at the Commonwealth Mycological Institute, Kew, England under I. M. I. No. 271154.

Alternaria tenuis is known to cause leaf spot disease of *Chrysanthemum indicum* in Maharashtra[1] and other ornamentals like *Centuria cyanus* L. and *Bougainvillea spectabilis* Will[2]. *A. chrysanthemi* is also known to cause a leaf spot disease of *Chrysanthemum indicum*[3]. This blossom blight hitherto has been reported previously from India.

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Stomach toxicity of diflubenzuron (Dimilin 25 WP) against the larvae of mustard leaf webber *Crocidolomia binotalis* Zell. (Pyralidae : Lepidoptera)

Diflubenzuron (marketed as Dimilin 25 WP) is well known as a chitin synthesis inhibitor in insects. It is categoried as a fourth generation insecticide for its selective action. It is hoped that this chemical will occupy a status in future pest management programme. The chemical is also reported to have a fairly high degree of ovicidal, larvicidal and pupicidal properties against various insect pests. It also causes morphogenetic deformities in eggs and pupae. A series of laboratory tests on the biological effectiveness of diflubenzuron (Dimilin 25 WP) against the larvae of mustard leaf webber, *Crocidolomia binotalis* Zell; were undertaken in the Department of Entomology, College of Agriculture, Bhubaneswar during winter 1985. This pest has occupied the major pest status in the mustard growing belts of Orissa, West Bengal, Bihar and some parts of Andhra Pradesh. Attempts have been made to findout the stomach toxicity of this compound against the various larval instars of mustard leaf webber at different concentrations i.e. 0.025%, 0.05%, 0.1% and 0.2% in replicated experiments.

The test insects were reared in the laboratory on a high yielding mustard variety "Varuna" as per the rearing technique developed by Pani and Rout[3] To test the stomach toxicity, leaf dip method was employed. Ten pre-conditioned larvae (larvae without food for 6 hours before treatment) of various instars were taken separately in separate petri-dishes. Mustard leaves were dipped separately in diflubenzuron suspension prepared at four concentrations i.e. 0.025%, 0.05%, 0.1% and 0.2% for 1 minute. The treated leaves were then dried under fan. Such leaves were then supplied in different petri-dishes to the preconditioned larvae. After feeding for 6 hours the leaves were replaced by untreated leaves. Observations on the mortality of the larvae were taken at an interval of 24 hours upto 5 days. During the period of observation only untreated fresh leaves were supplied to the larvae for feeding. The mortality data thus

TABLE 1 : Mortality of different larval instars of mustard leaf webber, *C. binolalis* Zell. at different concentrations of diflubenzuron suspension by leaf dip method with exposure period of 6 hours

Larval instars	Concentration (%)	Mortality percentage after different hours of post treatment period								
		24 hrs	48 hrs		72 hrs		96 hrs		120 hrs	
		Mortality	Mortality	LC_{50}	Mortality	LC_{50}	Mortality	LC_{50}	Mortality	LC_{50}
First	0.025	3.3	33.3	0.0792	73.3					
	0.05	0	46.6		76.6					
	0.1	6.6	53.3		83.3					
	0.2	10.0	66.6		90.0					
	Control	0	3.3		10.0					
Second	0.025	0	3.3		16.6	0.1619	33.3	0.0786	43.3	
	0.05	0	13.3		26.6		40.0		46.6	
	0.1	3.3	20.0		43.3		56.6		63.3	
	0.2	0	26.6		53.3		70.0		80.0	
	Control	0	0		0		3.3		6.6	
Third	0.025	0	3.3		13.3		26.6	0.1094	33.3	0.0657
	0.50	0	10.0		20.0		33.3		43.3	
	0.1	0	16.6		36.6		46.6		56.6	
	0.2	3.3	23.3		46.6		66.6		76.6	
	Control	0	0		0		0		0	
Fourth	0.025	0	0		6.6		23.3	0.1644	26.6	0.1151
	0.50	0	0		13.3		30.0		36.6	
	0.1	0	6.6		26.6		36.6		43.3	
	0.2	0	16.6		33.3		56.6		66.6	
	Control	0	0		0		3.3		3.3	

obtained is presented in Table 1 along with the LC_{50} values calculated by probit analysis.

It was observed that the first instar larvae of mustard leaf webber were most susceptible to the compound and more than 50% mortality was recorded 2 days after the treatment at concentration of 0.1% and above. Similarly in case of the second instar larvae, more than 50% mortality was noted 3 days after the treatment and for 3rd and 4th instars 4 days after the treatment. Thus it is indicated that the earlier instars are more susceptible to the compound than the older instars. Further, higher concentrations of the compound i.e. 0.1% and 0.2% produced more lethal effects.

The LC_{50} values calculated by probit analysis are 0.0792 for the first instar larvae after 2 days of treatment and 0.1619 for the second instar larvae after 3 days of the treatment. For the third and fourth instar larvae, the LC_{50} values were 0.1094 and 0.1644 respectively. Similar results have been reported by Beevi and Dale[1] on *Spodoptera mauritia* and El. Sayed[2] on cotton leaf worm and *Sodoptera littoralis*. It is concluded that, the older larvae are less affected than the younger larvae perhaps due to the low absorption of the toxicant in the gut or may be due to the detoxification process by the insect enzyme system causing degradation of the active ingredient and subsequent excretion through faeces.

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Natural enemies of rice gundhi bug *Leptocorisa varicornis* Fabrecious in eastern part of Uttar Pradesh

The rice gundhi bug, *Leptocorisa varicornis* Fabrecious has, in recent years, attained the status of major pest in eastern part of Uttar Pradesh and adjoining area of Bihar causing appreciable damage to paddy crop chiefly at milky stage by sucking grain juice. It causes 10 to 40 per cent crop loss[1,2]. Panicles in heavily infested areas contain many shriveled and unfilled grain and usually remain erect[3]. Besides several other reasons, the large scale depletion of natural enemies seems to be the main reason. The awareness of deleterious side effects of an indiscreminate and ill-conceived application of pesticides has revived interest in biological control. Now, in recent years, the research is on way to control the pests by exploring the use of effective natural enemies particularly existing in the area. Information on various parasites and predators of *L. varicornis* and other allied species have been reviewed by Srivastava and Saxena[4], Rotschild[5] recorded arachnids viz., *Eucta* sp. (Tetragnathidae), *Argiope* sp. (Argiopidae) and *Thomisus* (Thomisidae) feeding on nymphs in the field. However, very little is known about parasite/predator of rice gundhi bug prevailing in this area. With these considerations, an extensive and intensive survey was carried out during 1980 to 1984 in Varanasi districts of eastern part of Uttar Pradesh to record parasites and predators of rice gundhi bug in and around rice field in this area. *L. varicornis* is common species occurring in this area and were found parasitised and predated by different animals (Table 1).

TABLE 1 : Record of parasites and predators of rice gundhi bug in Varanasi districts of eastern Uttar Pradesh

Sl. No.	Name of organism	Remarks
	Parasite	
	1. Insect	
	(i) *Gryon flavips*	A few parasitised eggs of rice gundhi bug was collected from in and around rice fields almost at all experimental sites. Parasites insert their ovipositor in-side host eggs and lay egg.
	Predator	
	1. Insect	
	(i) Grass hopper*	These insects were seen feeding on eggs of rice gundhi bug laid on rice leaf by way of scrapping the leaf with the help of labial palp.
	(ii) Ant*	These small tiny ants were seen either feeding on nymphs and adults or carrying them to their nests after puncturing in the body of prey.
	2. Arachnids (spider)	
	(i) *Plexippus* sp.**	These spiders either trapped the adults to the webs & sucked the body fluid after paralysing them or jumped over the nymphs of gundhi bug and prey them mostly towards the front.
	(ii) *Marpissa* sp.**	
	(iii) *Sparassus* sp.**	
	(iv) *Oxyope ratanal* Tikader	
	3. Non-arthropod predator	
	(i) Indian toad (*Bufo melonosticus*)	Adult gundhi bug attracted to light were observed being prayed by the Indian toads.
	(ii) Lizard (*Hemidactylus flavivirdis*)	They were observed preying over the attracted gundhi bugs at the source of light.
	(iii) Birds (*Acridotheres tristis*)	These birds were seen feeding on both the stages of rice gundhi bugs in rice fields.

* Specimens not identified.

** Species not identified.

During the investigation, the insect parasite *Gryon flavips* was recorded and the predator like grass hopper, ant, spiders, lizard toad and bird were seen feeding either nymphal or adult stage or both the stages of rice gundhi bug (see table). Amongst natural enemies recorded, the spiders attacking either nymphal or adult stages of rice gundhi bug seem to be a potential group of predator. The two species of spiders *viz.*, *Plexippus* sp. and *Marpissa* sp. belonging to family Salticidae were frequently seen preying mostly upon nymphal stages in the paddy field. It is evident from the literature that there is no information available on this group of spiders preying on different stages of this insect. Therefore, any study on this group of spiders will be very helpful in establishing this predator in our country which can be taken advantage in integrated pest management programme.

The authors express their sincere thanks to Director, Zoological Survey of India, Calcutta who has most generously helped in identifying the specimens.

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Chemical composition of some of the edible fishes of Karwar

The sea food has been gaining tremendous importance in human nutrition. Several efforts have been made to evaluate the nutritive value of commercially important fishes like oil sardine[1-3], pomfrets[4,5] and other commercially important species of 16 Indian fishes[6]. Attempts have also been made to study the chemical composition in prawns, clams and crabs of India[7-10].

It is quite evident from above studies that most of the studies have been restricted totally on commercially important species. However, information on the food value of lesser important commercial fishes which form food for poorer class in the society, is remarkable lacking. Hence a study on proximate composition was made on less exposed species viz., *Thryssa dussumieri*, *T mystax*, *Pomadasys maculatus*, *P. hasta*, *Otolithes ruber* and *Johnius vogleri* to evaluate their nutritive value.

The fishes were collected afresh from the landing centres of Karwar during January-March 1980 and the samples were prepared for chemical analysis after being subjected to preliminary treatment[11].

Water and ash content of the samples was determined according to the methods of AOAC[11] Crude protein was calculated by multiplying the total nitrogen, obtained through micro-kjeldahl method with 6.25[11]. A modified method of Bligh and Dyer was used to determine the fat content of the samples[12]. Carbohydrate was estimated by proximate difference.

The results of the proximate composition of different fishes indicated no similarity in any of the proximate constituents studied. These variations could be attributed to Halberg's[13] extrinsic and intrinsic factors such as the nature of the habitat, feeding habits and feeding intensity, breeding state and other environmental elements which account for the biochemical variability. For instance, closely related species like *O. ruber* and *J. vogleri* exhibited great variation in fat and protein content while difference in concentration of carbohydrate and ash was negligible (Table 1). Similarly the species of *Thryssa* also differed in percentage of proximate composition. The fat (6.55%) and protein (17.00%) contents were found to be high in *T. mystax* whereas *T. dussumieri* showed comparatively a lesser amount of fat (5.30%) and protein (16.64%). However, higher content of water was observed in the latter species (Table 1). Of the species of *Pomadasys*, *P. hasta* had high protein (76.00%) and fat (6.10%) than those of *P. maculatus*.

The moisture content in the studied species ranged from 74.91 in *T. mystax* to 76.10% in *O. ruber*.

TABLE 1 : Proximate composition in fish muscle (% wet weight)*

Species	Water	Fat	Ash	Protein	Carbo-hydrate
Thryssa dussumieri	76.30	5.30	1.38	16.64	0.38
Thryssa mystax	74.91	6.55	1.23	17.00	0.31
Pomadasys maculatus	75.80	5.56	1.55	16.73	0.37
Pomadasys hasta	76.00	6.10	1.40	16.13	0.37
Otolithes ruber	76.80	5.50	1.18	16.20	0.32
Johnius vogleri	76.54	4.50	1.10	17.60	0.35

* Average of 10 samples

It is interesting to note that the ash content was high in both the species of *Pomadasys* while the lower values were recorded in sciaenid species ranging from 1.10 to 1.18%.

Protein content was minimum in the muscle of *P. hasta* (16.13%) and the maximum was recorded in *J. vogleri* (17.60%). Generally the carbohydrate concentration did not vary much in between the species. It ranged between 0.31 (*T. mystax*) and 0.38% (*T. dussumieri*).

Above results indicate that all the species of fish examined exhibited a good proportion of protein, moisture, fat and ash content whose values can be well compared with other commercially important fishes like mullets and mackerel[14], crab[15], prawns[8], tuna[16] and other species[6].

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Pollination studies in *Crotalaria juncea* L.

The reproductive success of cross-pollinated plants depends heavily on the abundance of specifically associated pollinators[1], and their morphological and behavioural adaptations necessary for pollination[2-3]. The present study was conducted during September, 1984 in sub-tropical Hisar located in North-Western plains, of the country between 28° 59'-29° 46' N (Latitude) and 75° 11'-76° 18'E (Longitude) at 215.2 m (altitude) on the plant breeding farm of Haryana Agricultural University, Hisar where *Crotalaria juncea* is grown regularly for seed production. Hourly observations starting from 0800-1800 h on population/m^2 of different bee species were recorded on *C. juncea* following Sihag[4]. The percentage of each bee species visiting *C. juncea* flowers was calculated as follows:

$$\text{Percentage of each bee species (\%)} = \frac{\text{Number of bees of a particular species (n)}}{\text{Total number of bees of all the species (N)}} \times 100$$

The pollinating effectiveness of each bee species was judged by (i) its abundance on the crop, (ii) its distribution pattern on the crop, (iii) its availability on seasonal and diurnal basis and, (iv) its morpho-ethological behaviour on the crop.

TABLE 1 : Percentage proportion of different bee pollinators on *Crotalaria juncea* flowers during September, 1984

Family	Bee species	Percentage proportion[a] on September 11	14	19	Average[b]
Megachilidae					
	Megachile lanata	46.45	48.69	47.00	47.38
	M. biocolor	5.10	4.46	3.67	4.41
	M. flavipes	8.09	6.61	7.38	7.36
Apidae					
	Apis florea	3.66	4.84	5.19	4.56
	A. dorsata	13.66	17.59	18.91	16.72
Halictidae					
	Nomia. sp.	2.87	2.04	0.88	1.90
	Halictus sp.	1.86	1.36	1.94	1.72
Anthophoridae					
	Xylocopa fenesterata	7.99	5.95	7.96	7.30
	X. pubescens	3.08	1.11	0.88	1.69
	Pithitis smaragdula	7.24	7.35	6.19	6.92
	Total	100.00	100.00	100.00	100.00

Each percentage value is mean of (a) 50 and (b) 150 observations.

Data in Table 1 show that bee species belonging to families; Apidae, Anthophoridae, Megachilidae and Halictidae visited *C. juncea* flowers. Their abundance was in the order : *Megachile lanata>Apis dorsata > M.flavipes > Xylocopa fenesterata > Pithitis smaragdula > A.florea > M. bicolor > Nomia sp. > Halictus sp. > X. pubescens.* Among the various bee pollinators, *M. lanata* was an important pollinator of this crop, since it was represented in large numbers throughout the day. Its emergence also synchronized with the blooming period of this crop. It generally alighted on the keel and pressed it down to expose the genital column. *Megachile lanata* then jerked their bodies in such a way that scopa present on their ventral side, rubbed heavily against the exposed stigmas. Thus the behaviour of this bee species is of particular importance in seed setting of this crop. Though other bee pollinators like *Xylocopa fenesterata, X. pubescens* and *A. dorsata* with their heavier bodies were able to press the keel to expose the genital calumn but their population was too low to rely upon. The other bee pollinators like *A. florea, P. smaragdula, Nomia* sp. and *Halictus* sp., were much smaller and not effective to press the keep to expose the genital column necessary for pollination. Evidently, *M. lanata* is behaviourally, physiologically and morphologically better adapted to pollinate flowers of this crop because it was (i) more abundant than rest of the bees; (ii) works consistently at all hours of the day; (iii) distributes more compactly on the crop as compared to other bee pollinators, and (iv) is more easily manageable under artificial conditions.

Senior author (DPA) wishes to thank Indian Council of Agricultural Research, New Delhi for financial assistance in the form of senior Research Fellowship.

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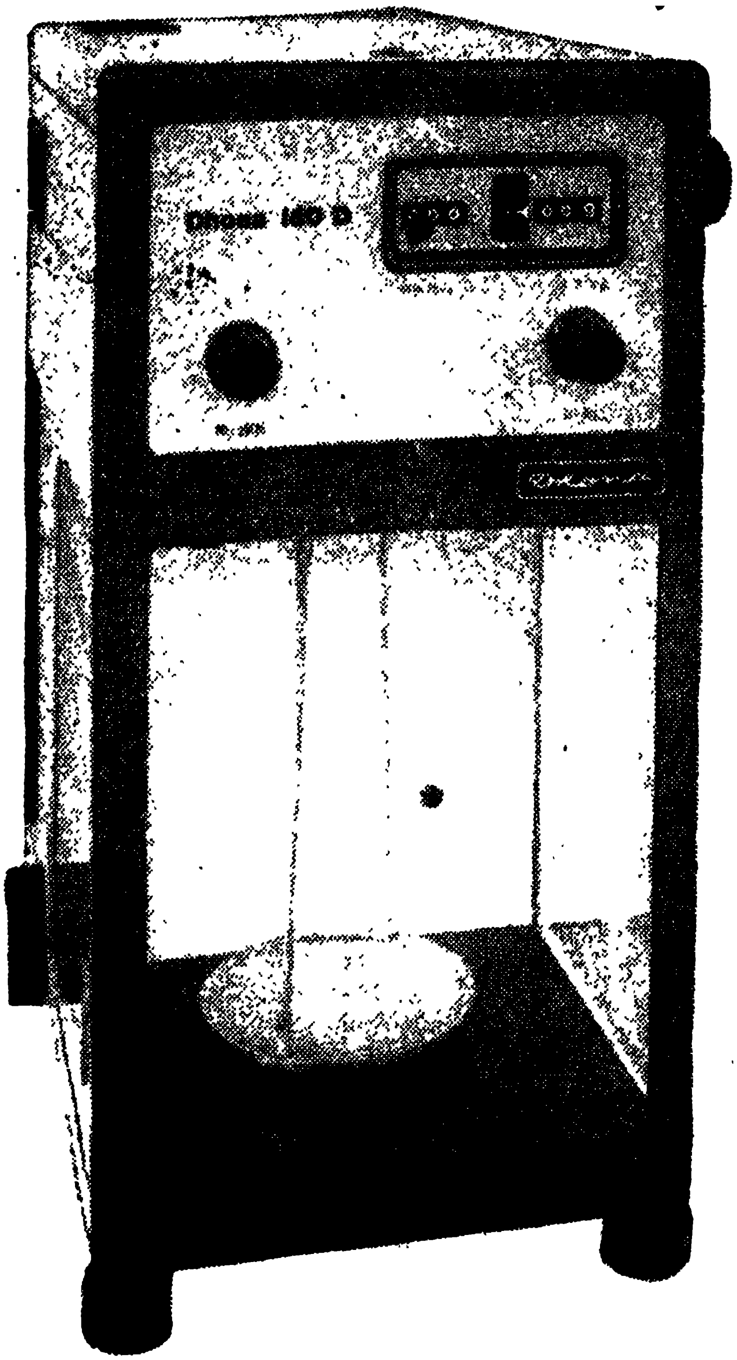

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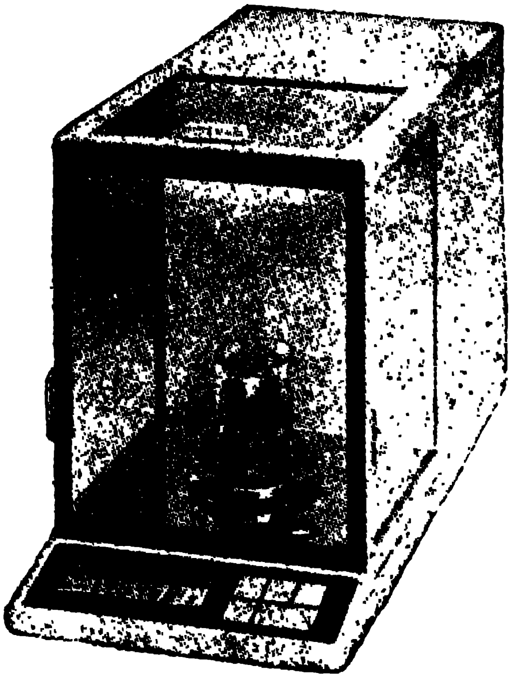

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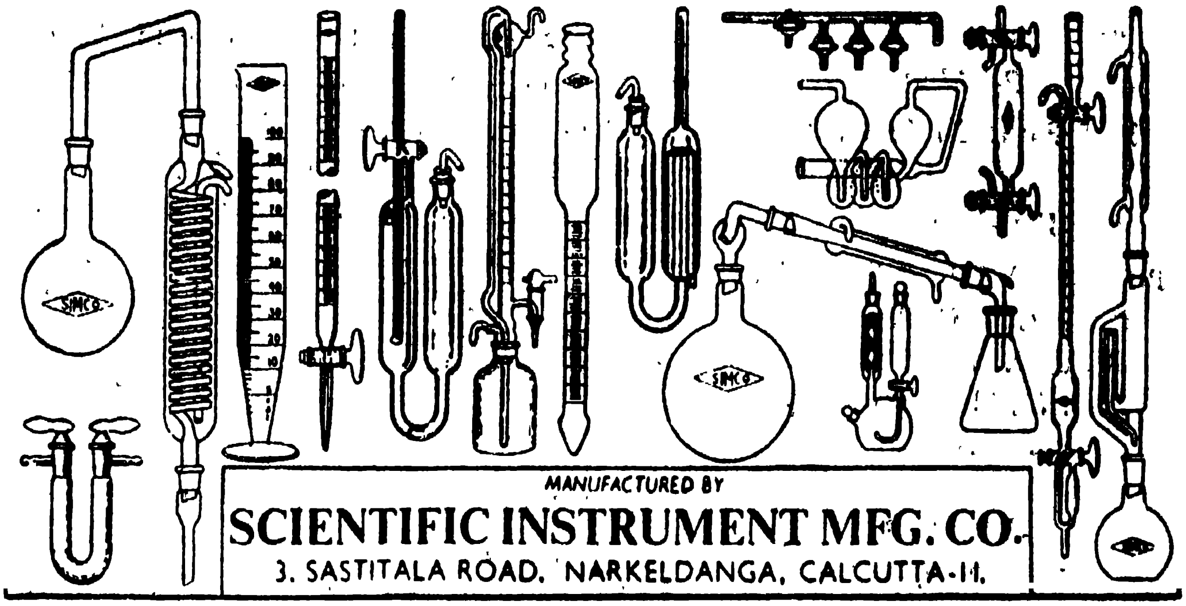

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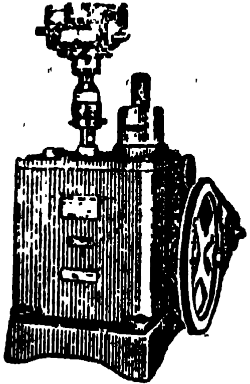

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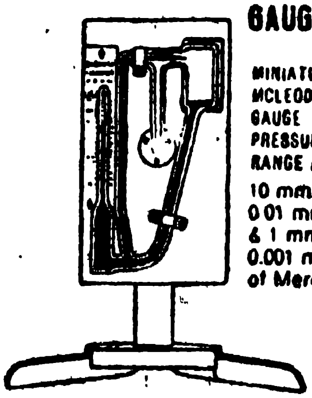

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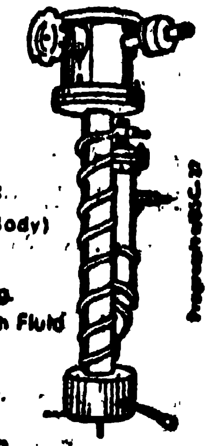

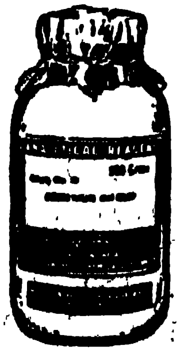

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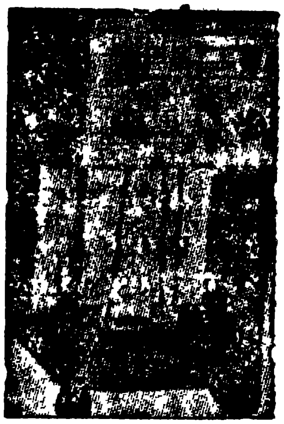

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THOUGHTS FOR AUGUST

IN the month of August every year the thoughts of right thinking men and women around the world turn towards mankind's folly committed in 1945 in this month. To force surrender from the Japanese and bring an end to the world war II, atomic bombs were dropped on the cities of Hiroshima and Nagasaki on 5th and 9th of the month thus letting loose the most sinister form of horror created by man for the first time. The destruction and continued suffering of the affected population stunned not only the vanquished but the victors too. The world was led into a kind of stupor, the recovery from which was rather slow.

The kind of cold war which began practically immediately after the secession of world war II, activities divided the world into two camps with mutual suspicion and fear of preparation of newer and more sinister horror devices. The race in sophistication of fission and fusion bombs and the accumulated destructive power on both the sides increased to such an extent that life on earth could be wiped out completely several times over. It is very difficult to understand the psychology behind this cumulative process which compresses such great destructive power behind the single pressing of a switch. A mere sense of self preservation would have always accompanied by some proportion of self-sacrifice and charity towards others. It seems it was a sense of gaining world supremacy that lead to the brink of total annihilation.

However, the common man on the street and the sensible people in the world have not forgotten those two days in August 1945 and have remembered them every year. Thus a sense of world brotherhood for survival created by this movement slowly percolated the intelligensia of the world which in turn impressed upon the world powers to feel the realities and remove the feeling of insecurity. The force of public opinion thus created finally forced the super powers to come to the negotiating table and take positive steps to make the world a safer place to live in. The INF treaty signed in December 1987 was just a beginning (See *Science and Culture*, December 1987). Since then the treaty has been ratified by both the sides and the procedure of destruction of intermediate range nuclear arsenel by both sides has begun. This year, in this background the Hiroshima and Nagasaki days were remembered with a sense of relief.

Reflecting a bit deeper about the world and its rapid advancement, can we really feel complete security ? In 1984 a conference of scientists had declared that if a nuclear war broke out, the world will be engulfed by such a climatic condition, which they called nuclear winter, which would destroy all life on earth. It is a sinister thought, but it was arrived at by proper scientific reasoning and calculations. With the working of INF treaty no doubt we have pushed such a situation away and with the total control of nuclear weapons it might not be created at all. But is the world safe from leading towards such climatic conditions because of our other activities ? A concerned apprehension was expressed recently at a meeting of our 300 scientists, climatologists, city planners, economists and politicians from 40 countries meeting in Toronto in Canada for four days. According to them an unsanctioned globally pervesive enormous experiment that humanity is conducting is tantamount with a global nuclear war. The indication was towards the grim picture if action was not taken to reverse the Greenhouse effect owing to burning of fossil fuels which were releasing carbon dioxide chlorofluorocarbons and other pollution gases.

The earth is surrounded by what is known as the ozone layer. It is just a thinly scattered ozone molecules in the rarefied air from 15 to 40 km high. When incoming sunlight passes by these molecules on its' way to the ground, the ozone molecules absorb almost all the ultraviolate components received from the sun. Depletion in this layer of ozone, ultraviolate percolates to the ground which is dangerous to any form of life on ground. Sun burns will run wild and so will skin cancer. Eye cataracts and deaths from heat waves will drastically increase. Plants, food crops and animals may be wiped out. Now this protective ozone layer is thinning owing to an increasing number of pollutants. From the discussions in the conference it seems 95% of CO emissions originates from the northern hemisphere and only 5% from the southern hemisphere. According to the Indian representative participating in the discussion, 85% of the fossil fuel was burnt by the developed world and only 15% by developing countries. He appealed that the developed world should bear the cost of correcting the situation.

The Secretary-general of the Geneva based World Meteorological Organisation called for a law of the Atmosphere to both protect this thin shield of air on which life itself depends and to ensure the international exchange of scientific information needed to maintain a continuous watch on our planets most important and threatened resource.

The prime minister of Canada had declared in his inaugural address. "Products and processes that conserve energy are recycled or recyclable, biodegradable and free of ozone depleting substances will be indentified by a distinctive made in Canada Logo".

The scientists predict that the impact of Greenhouse gases could lead to average global warning of upto 4.5°C within the next 50 years. The climatic changes envisaged "will aggravate the problem of food security and lead to more frequent instances of fluctuations in food supplies and occurrences of famines. Thus it is imperative for governments and international community to sustain the agricultural resource base in the light of the growing environmental threat to global good security.

In another report appealing for cutting down the use of chlorofluorocarbons to 50% by 1999, it was stated that the warming of the atmosphere would have disasterous effect on the whole ecological balance. "The deserts will expand. The crops in today's marginal areas will be lost. Extremes of eather— storms, rainfall, frost or heat — may become more common. The sea level may rise one meter or more and with one third of the world's population living in low-lying coastal areas, such a development will have devastating consequences".

The problem stated cannot be solved by a single country or government and not by scientists alone nor politicians alone. It requires the combined, concerted efforts of most of the world community. We have already seen a couple years back that though the Chernobyl accident took place in Russia but practically half the world was affected and had to take precautionary measures. It is also not time to discuss and debate which country was responsible most for the impending disaster but to think collectively for measures to be applied for putting a break on the present rate of pollution before the end of this century so that we leave behind a livable earth in the coming century. ☐

B. B. Baliga

This month being the birth month (after the centenary) of Erwin Schrödinger, who by inverting quantum mechanics gave a new direction to modern physics, we are presenting in this issue a few articles on his life and works. The accumulated data of the pevious century could be properly analysed and understood in the light of his work. Physics made rapid strides using it. Schrödinger was a great thinker and being in touch with the old school had respect and interest for different philosophies. He tresspassed the boundaries of his subject into biology trying to understand nature as a whole. The subject of biophysics may be said to have originated due to his dabbling in biological sciences. Many biophysicists have confessed that they were prompted to take up research in biophysics after reading Schrödinger's little monograph "what is life?" Here we have tried to collect three essays by rather young physicists, which throw light on different aspects of Schrödinger's life. This is our tribute to that great thinker. —*Editors*

ERWIN SCHRÖDINGER : A TRIBUTE ON HIS BIRTH CENTENARY

S. B. RATH*

The Man

Erwin Schrödinger (pronounced as Shroi-ding-er) was born on 12th August 1887 at Vienna, Austria. He was educated at the University of Vienna and received his doctorate from the same university in 1910. When the first world war broke out he fought as an artillery officer and then settled in Germany after the war. He was professor of theoretical physics at the Technische Hochschule, Stuttgart till 1920. From 1921 he was professor of mathematical physics at the University of Zurich. It was here that he developed his theory of Wave Mechanics in which he reconciled the corpuscular and undulatory phenomena observed in the behaviour of light and subatomic particles. For this he was awarded the Nobel Prize in 1933 for physics which he shared with P. A. M. Dirac. In 1926 he succeeded Max Planck as the professor of theoretical physics in the University of Berlin. When Adolf Hitler rose to power, he left Berlin in 1933 to teach briefly at Graz in Austria. While still in Germany he was interceded during a Nazi raid on a Jewish ghetto. TheStormTroopers would have beaten him to death if one of them had not recognised him and prevented the attack. When Germany usurped control of Austria too, Schrödinger left for Ireland to teach at the Institute of Advanced Studies in Dublin, of which he subsequently became the Director. In 1956 he returned to the University of Vienna, after having delivered the famous Tarner Lectures at the Cambridge University. He remained at Vienna till his death on the 4th January 1961.

Much of what he has written is inaccessible to everyone save specialists in statistical thermodynamics and wave mechanics. Fortunately, however, not all of his works are directed to technical audience. Among these mention may be made of 'What is Life?' (1944), ' Science & Humanism' (1951), 'Nature & the Greeks' (1954) and 'Mind & Matter' (1958).

The Physicist

After Young and Fresnel light is a wave. Since then light was a regarded as a wave motion because many of its properties could be explained in the following manner i.e. the fundamental wavelike property was interference : a crest could combine with a trough to produce a tranquil place, a light could cancell other light; whereas it was difficult to envision a particle as having this property. On the other hand, some of the properties of radiation require that it be treated as a particle (called a photon) which carries some energy (called a quantum). By 1920, with Planck's quantum, Einstein's photon and Bohr's atom it was clear, inspite of its wavelike properties in interference and diffraction, that when it came to transfers of energy or momentum, light behaved in many respects like a particle. Thus, radiation exhibits a wave-particle duality i.e. some of the properties of radiation are characteristic of waves whereas others are typical of particles. The association of wave properties with material particles such as electrons, protons and neutrons was established by de Broglie and was subsequently confirmed by experiment.

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A possible physical interpretation, therefore, is that the subatomic particles must be treated mathematically by the same equations as apply to waves.

The next step was taken by Schrödinger in 1926 who applied mathematical procedures to the wave-particle duality concept of matter. Through his research Schrödinger wanted to combine the Bohr atom model with de Broglie's matter waves. In Schrödinger's model the electron could exist in any orbit. Around each of these electrons, matter waves spread out in a specified number of wavelengths. This led to the development of Wave Mechanics which has been outstandingly successful in interpreting many properties of the atom. Another mathematical approach, called the Matrix Mechanics, was developed at about the same time. Both are aspects of what is now known as Quantum Mechanics.

With de Broglie and Schrödinger the confusion was almost ovr and the light not only to be treated sometimes as a wave and sometimes as a particle, but matter itself, the ultimate, the final repository of atomic and corpuscular properties—the atom of Democritus, Gassendi and Newton—would now associate a wave with them in some mysterious way.

Contained in what is now known as Schrödinger equation, it is the heart of quantum physics. In 1926 Schrödinger published a series of papers containing his now famous equation and its applications to many of the basic problems of quantum theory.

As we know, the position of an electron (or of other subatomic particle) of definite momentum or energy cannot be known exactly because of the Heisenberg's Uncertainty Principle (i.e. It is impossible to determine simultaneously the exact position and momentum of any particle, if the position of the particle is exactly known, then the momentum is completely uncertain and vice versa). All that is possible, therefore, is to state the statistical probability that the particle will be found at any given point. Wave mechanics then postulates that this probability can be expressed by a mathematical expression similar to that used for describing wave behaviour in general. In otherwords, the statistical probability of finding a particle in a specified position can be represented by an equation of the same form as that which describes the amplitudes of waves, for example, sound waves in space.

Schrödinger's wave equation gives the de Broglie wave associated with an electron or any other particle or finally any quantum system. Given the mass of the particle, and given the forces to which it is subjected, let us say gravitational or electromagnetic, then Schrödinger equation gives the possible waves associated with this particle; the waves (functions of position and time) give a number associated with any position in space at any arbitrary time. And they are designated by the hardest working symbol in twentieth century physics: the wave function

psi (x, y, z; t)

Perhaps the most natural interpretation of the wave associated by Schrödinger and de Broglie with the electron would be to say (as Schrödinger attempted to do) that in some sense this wave represented the density of matter. With this interpretation the electron, rather than having its entire mass and charge concentrated at a point, would have that same mass and charge smeared over some region of space, the amount of mass or charge in a given region being proportional to the magnitude of the square of the wave function.

The Scrödinger equation has many application in the study of the behaviour of small particles : in particular it was used to explain the spectrum of atomic hydrogen more exactly than Bohr had been able to do and without the assumptions that Bohr had found it necessary to make.

Einstein in a letter to Schrödinger dated December 22, 1950 wrote, "you are the only contemporary physicist, besides Laue, who sees that one cannot get around the assumption of reality if only one is honest" revealing the degree of scientific solitude to which his position on quantum theory drove him. One may speculate, is this indeterminacy a necessity or a reflection of quantum mechanics being an incomplete description of nature?

Schrödinger's Cat

The paradox of Schrödinger's cat occupies a unique position among the Gedanken (thought) experiments of quantum physics in its simplicity, intuitive appeal and ability to shake up a physicist hearing about it for the first time.

A cat is placed in a steel chamber (Fig. 1), together with the following hellish contraption (which must be protected against direct interference by the cat) : in a Geiger counter there is a tiny amount of radioactive substance, so tiny that may be, within an hour one of the atoms decays, but equally probably none of them decays. If one decays then the counter triggers and via a relay activates a little hammer which breaks a container of cyanide. If one has left this entire system for an hour, then one would say that the cat is still living if no atom decayed. The first decay would express this by containing equal parts of the living and the dead cat.

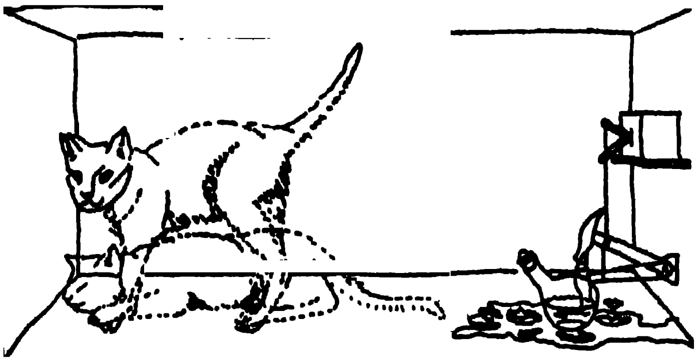

Fig. 1. Schrödinger's Cat

The typical feature is that indeterminacy is transfered from the atomic to the crude macroscopic level, which then can be decided by direct observation. This prevents us from accepting a 'blurred model' so naively as a picture of reality.

Reflection on the cat paradox has much to offer to anyone concerned about the foundations of quantum mechanics.

Einstein's Principle of Local Reality & the EPR Paradox

Einstein asserted in the face of almost universal opposition that quantum mechanics was fundamentally unsatisfactory. Einstein's primary idea was that the concept of physics relate to a real outside world independent of the perceiving subject. The physical objects of this world are arranged in a space-time continuum. At any given time objects A and B situated in different parts of space have independent existence. This relative independence asserts the principle : "external influence on A has no direct influence on B", also known as the 'principle of contiguity'. For the composite physical system consisting of spatially separated parts A and B, it means that B shouldn't be affected by whether or what experiments have been performed on A. We shall refer this as Einstein's principle of local reality. Einstein defends, " if one abandons the assumption that what exists in different parts of space has its own, independent real existence, then I simply cannot see what it is that physics is meant to describe. For what is thought to be a 'system' is, after all, just a convention, and I cannot see how one could make statements about parts of it."

In 1935 Einstein, Podolsky & Rosen (EPR) posed the question, "can quantum mechanical description of physical reality be considered complete?" EPR infact states the necessary requirement for completeness of a theory i.e. "every element of the physical reality must have a counterpart in the physical theory" and the sufficient condition to identify such elements of reality is possible "if without in any way disturbing a system we can predict with certainty the value of a physical quantity, then there exists an element of physical reality corresponding to this physical quantity."

Einstein's principle of local reality is inconsistent with the assertion that the wave function gives a complete description of physical reality for an individual system.

Schrödinger viewing the EPR paradox as a serious difficulty had noted, "it is rather discomforting that the theory should allow a system to be steered or piloted into one or the other type of state at the experimenter's mercy inspite of his no access to it"

Collapse of the Wave-packet

According to Dirac, "a measurement always causes the system to jump into an eigenstate (characteristic and independent state) of the dynamical variable that is being measured". Thus the continuous evolution of the wave function according to Schrödinger equation is suspended during the act of measurement. This assertion is called the "collapse or reduction of the wave-packet" and is notoriously ill-understood feature of quantum doctrine. Particularly painful is the fact that since the objective part of the world undergoes the 'collapse', and since the subject-object division of the world is ill-defined, which of the natural processes undergo 'collapse' and which develope continuously according to Schrödinger wave equation is not well-defined.

There is no agreement on what actually causes collapse and when. Bohr attributes the collapse to the uncontrollable interaction between subject and object, whereas von Neumann attributes to the consciousness of the observer and pauli to a 'creation' existing outside the laws of nature even though it cannot be influenced by the observer.

In Schrödinger's words, "the best possible knowledge of a 'whole' does not necessarily include the best possible knowledge of all its 'parts', even though they may be entirely separated and therefore virtually capable of being "best possibly known" i.e. "of possessing each of them a representative of its own". Schrödinger further said, "I wouldn't call that 'one' but rather 'the' characteristic trait of quantum mechanics, the one that expresses its entire departure from the classical line of thought."

Schrödinger—the Philosopher

Erwin Schrödinger was a keen observer of nature and his thought was profound. In an essay titled 'Is Science a Fashion of the Times' he wrote, "the first observations of nature by the primitive man didn't arise from any consciously constructed mental pattern. The image of nature which primitive man formed for himself emerged automatically, as it were, from the surrounding conditions, being determined by the biological situation, the necessity of bodily sustenance within the environment, and the whole interplay between bodily life and its vissitudes on the one hand and the natural environment on the other. I mention this point in order to forestall the objection that from the very start a compulsory element might be attributed to the overpowering sway of objective facts. This is clearly not true, the origin of science being without any doubt the very anthropomorphic necessity of man's struggle for life".

Our civilisation forms an organic whole. Those fortunate individuals who can devote their lives to the profession of scientific research are not merely botanists or physicists or chemists, as the case may be. They are men and they are children of their age. The scientists cannot shuffle off his mundane coil when he enters his laboratory or ascends the rostrum in his lecture hall. In the morning his leading interest in class or in the laboratory may be his research ; but what was he doing the afternoon or the evening before? He attends public meetings just as others do or he reads about them in the press..... In short, we are all members of our cultural environment : so said Erwin.

Schrödinger and the Greeks

In the classic work Nature & the Greeks he said that we should return to a study of scientific thought of the Greek philosophers. For their beliefs had this virtue that we lack : 'wholeness' He further said, " the world is big and great and beautiful. My scientific knowledge of the events in it comprises hundreds of millions of years. Yet in another way it is ostensibly contained in a poor seventy or eighty or ninety years granted to me — a tiny spot in immeasurable time, nay even in the finite millions and milliards of years that I have learnt to measure and to assess. Whence come I and whither I go? That is the great unfathomable question, the same for everyone of us. Science has no answer to it. Yet science represents the level best we have been able to ascertain in the way of safe and incontrovertible knowledge... And from all these we feel that any thought we attain to during this time will not have been thought in vain".

Schrödinger observes that we do not belong to this material world that science constructs for us. We are not in it, we are outside. We are only spectators. The reason why we believe that we are in it, that we belong to this picture. Our bodies belong to this.

Admiring the Greeks, Schrödinger said that numbers are at the back of everything. The essence of mathematical thought is that from the material setting it abstracts numbers (lengths, angles etc.) and deals with them and their relations as such. It is in the nature of such a procedure that the relations, patterns and formulae are arrived at in this way, and very often these turn out to be quite unexpectedly applicable to material settings widely different from those out of which they were originally abstracted. The mathematical pattern or formulae, all of a sudden brings order into a domain for which it was not intended and which was never thought of when the mathematical pattern was derived. Such experiences are very impressive and very apt to create the belief in the mystical power of mathematics. "Mathematics" appears to be at the bottom of everything, since we find it unexpectedly where we had not put it in. Science has now learned to be cautious enough not to take for granted an intrinsic cognateness where there may be only a formal analogy resulting from the very nature of mathematical thought. But in the infancy of the sciences, rash conclusions, of the mystical nature characterised above, must not astonish us.

Schrödinger further observed that the grand idea which informed these men (the ancient Greek thinkers) was that the world around them was something that could be understood, if one only took the trouble to observe it properly. They saw the world as a rather complicated mechanism, acting according to eternal innate laws, which they were curious to find out. This is, of course, the fundamental attitude of science upto this day. To us it has become flesh of our flesh, so much so that we have forgotten that somebody had to find out, make it a programme, and embark on it. Curiosity is the stimulus. The first requirement of a scientist is to be curious. He must be capable of being astonished and eager to find out. Plato, Aristotle and Epicurus emphasized the import of being astonished. And this is not trivial when it refers to general questions about the world as a whole.... the second step is the recognition that all matter of which the world consists has, with all its infinite variety, yet so much in common, that it must be intrinsically the same stuff.

"Anaximander's denial of the universal world material was identical with any known stuff and inventing a name 'boundless' for it had an antiquity in itself, which now appears to be profound", said Schrödinger. The following agnostic and sceptic fragments of Democritus (460 BC) had impressed Schrödinger the most (translation Cyril Bailey):

(D. fr. 6) A man must learn on this principle that he is far removed from truth.

(D. fr. 8) To learn truly what each thing is, is a matter of uncertainty.

(D. fr. 117) We know nothing truly, for the truth lies hidden in depth.

(D. fr. 125) The famous dialogue between the Intellect and the Senses—

Intellect : Sweet is by convention and bitter by convention, hot by convention, cold by convention, colour by convention; in truth there are but atoms and the void.

Senses : Wretched mind, from us you are taking the evidence by which you would overthrow us? Your victory is your own fall. □

ERWIN SCHRÖDINGER AND THE CREATION OF WAVE MECHANICS*

GAUTAM GHOSH**

> **"It cannot be that axioms established by arguments should avail for the discovery of new works; since the subtlety of nature is greater many times than the subtlety of argument. But axioms duly and properly formed from particulars easily discover the way to new particulars, and thus render science active".**
>
> *—Francis Bacon*
> *"The Idols", Aphorism XXIV*

1. Erwin Schrödinger, the Man

Erwin Schrödinger was born on August 12, 1887 in Vienna; at that time the capital of the Austro-Hungarian empire. Schrödinger had his early education at home. Later he studied at the Akademische Gymnasium, a grammer school which emphasized on classical education and the University of Vienna, which he joined in 1906, the same year that Boltzmann, who held the chair of theoretical physics there, died under tragic circumstances. Naturally Boltzmann's ideas were the guiding spirit behind the activities in the department and Schrödinger's earliest publications, which appeared from 1910 onwards contained works on statistical mechanics and kinetic theory and also theory of dielectrics and X-ray diffraction, which was discovered by V. Laue in 1912. Meanwhile, Schrödinger obtained an assistantship in the laboratory of Franz Exener, the experimental physicist in the department and continued to work there till his marriage in 1920. During the war years 1914-1918 Schrödinger served in Italy as an artillery officer. In 1920 Schrödinger left Vienna and after brief stints at various places finally settled, in 1921, as full professor in the University of Enrich. His works in this period cover the specific heat of solids and automic spectra as understood in terms of the old quantum theory as also something which he undertook as a hobby : Theory of colours and vision. It was in Zurich that Schrödinger came to know of de Broglie's works which came out in *Annales de physique* (1924), through Peter Debye who urged him to study them and explain to his colleagues in seminars. It is interesting to note that wave-mechanics was invented and brought to adulthood through enough applications in one single year, 1926. With Planck's retirement in Berlin in 1927, Schrödinger was chosen as his successor. He accepted the offer, but not without misgivings. With the advent of the Nazis, Berlin became a hotbed of political activities and Schrödinger never concealed his distaste for the Nazis. With the coming to power of Hitler, people, including scientists, started leaving Germany and Schrödinger found he too could not continue to remain there anymore. So he went to Oxford in 1933, the same year that he received the Nobel Prize. The years 1927 to 1936 were devoted mostly to the applications of the new theory and efforts to bring it to terms with relativity. He worked on the Dirac electron theory and discovered the phenomenon of Zitterbewegung although his interests started diverging from that of most of his contemporaries. Along with Planck and Einstein, he belonged to the old school who never could accept the indeterminism inherent in the new theory and all his life Schrödinger tried to forsake duality and found a theory involving only a wave description. In 1936 Schrodinger went, as a professor, to Graz in his native Austria. With his known anti-Nazi sentiments, it turned out to be a dangerous move. Hitler came to power with the promise of a greater Germany and he proceeded to implement it by annexing Austria in 1938. This brought in its wake the persecution of Jews and political opponents. Public recantations were demanded from people known to profess contrary political beliefs. Schrödinger also suffered his share of humiliation. When, with the invasion of Poland the great war started, Schrödinger slipped across the frontier to Italy and arrived in Rome. For two years Schrödinger wandered around in Italy and the United States and then with the founding of the Dublin Institute of Advanced Studies, he became the first professor of theoretical physics there and later assumed the office of the Director. He retired in 1955 and went back to Vienna where a chair was created specially for him. His later day publications are on a variety of subjects, most of them being in general relativity and unified field theory which remained a passion for him till the end of his life. He did not participate in the burgeoning developments in quantum electrodynamics and particle physics (although he had a few papers in messon physics and Born and Infeld's electrodynamics) because he felt that the foundation i.e. quantum mechanics itself was not solid enough to permit building on it. After a period of prolonged illness Schrodinger died in Vienna on 4th January, 1961.

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* Part of the material was presented on the occasion of the Schrödinger Centenary, in a lecture arranged by the Research Fellows of Saha Institute.

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In all Schrödinger wrote ninety papers in scientific journals and of them only three were with collaborators. He was a lone worker belonging to the old school, for whom team work in Scientific pursuit held no meaning. Schrodinger was an outstanding pedagogue and this is evidenced from the books that he wrote. There are seven of them, all very slim (about a hundred pages each). The first book "what is life" which came out in 1944, is said to have launched many a physicist into a career in molecular biology. "Space time structure" ,which is an exposition of general relativity was written in 1950, followed by statistical thermodynamics, which is considered by many to be the best introduction to this subject. Because of his classical education he had a love for the ways of the Greeks and he wrote a book on it in 1954 : "Nature of the Greeks".

Schrödinger was unconventional in his way of life. Dirac reported[2], "when he went to the Solvay conference in Brussels, he would walk from the station to the hotel where the delegates stayed, carrying all his luggage in a rucksack on his back and looking so like a tramp that it needed a great deal of argument at the reception desk before he could claim the room that had been reserved for him". Hitler[3] gave a description of Schrödinger's life in Dublin, "like almost everybody else Schrödinger would cycle the three miles from his home to the Institute (only a few of the wealthier people could afford horse drawn traps), and he would go for long excursions on his bicycle. His study in his home was very simple. At times it gave the impression of an artist's studio than of a scientist's study. He like modelling, and often one could see a small statue that revealed his great artistic flair".

2. Development of a viewpoint

At the time when de Broglie's papers started getting published (from 1922 onwards) Schrödinger was working on the statistical mechanics of ideal gases. Bose's paper came out in 1924 and Einstein incorporated the new counting procedure adopted by Bose in his theory of the ideal gas. The influence of de Broglie's ideas on the developments in perfect gas theory has been unearthed by Hanle[4] from the Schrodinger-Einstein correspondence of those years. de Broglie had clear ideas about how the phase waves introduced by him should modify the statistical equilibrium of a gas. Thus in chapter 2 of his thesis entitled "Statistical Mechanics and Quanta" he wrote, "if the movement of gaseous atoms is accompanied by a propagation of waves, the receptacle containing the gas would be streaked in all directions by these waves. We are naturally led to consider, as in the conception of black-body radiation developed by J. Jeans, the phase waves formed by stationary systems (that is to say, resonant in the dimensions of the container) as being the only stable ones; only they occur in the study of thermodynamic equilibrium. This is some what analogous to what we have encountered in the subject of the Bohr atom ; there also, the stable trajectories are defined by a condition of resonance and the others have to be considered as normally unrealizable in the atom." This is nothing but box quantization for the molecules and de Broglie proceeded to show that the quantization condition arrived at is equivalent to putting one molecule in each phase cell of volume h^3. de Broglie went further and introduced Bose's counting procedure for light quanta as a 'new hypothesis ; if two or more atoms have phase waves that exactly superpose, by which one may say therefore that they are transported by the same wave, their movements may no longer be considered as entirely idependent and these atoms may no longer be treated as distinct entities in the calculation of probability . "With this prescription Schrodinger evaluated the energy spectrum of an ideal monatomic gas in 1925 to recover Einstein's theory of material gases in the wave picture and showed that in the high temperature limit it reduces to the classical theory with the correct Boltzmann counting (N). With this kind of background it did not take long for Schrödinger to arrive at the definitive formulation of wave mechanics[5, 6]. Quoting Dirac : "He has told me how he came to make his great discovery. With his work on spectra he was using, of course, Bohr's orbit theory, but he always felt that the quantum conditions in this theory were unsatisfactory and that atomic spectra should really be determined by some kind of eigenvalue problem in 1924, de Broglie published his work on waves associated with the motion of free particles. This influenced Schrödinger profoundly, and he set to work to try to generalize de Broglie waves to bound particles. He finally obtained a neat solution of the problem, leading to the appearance of the energy level as eigenvalues of a certain operator. He immediately applied his method to the electron in the hydrogen atom, duly taking into account relativistic mechanics for the motion of the electrons, as de Broglie had done. The results were not in agreement with observation. We know now that Schrödinger's method was quite correct, and the discrepancy was due solely to his not having taken the spin into account. However electron spin was unknown at that time and Schrödinger was very disappointed and concluded that his method was no good and abandoned it. Only after some months did he return to it, and then noticed that if he treated the electron non relativistically his method gave results in agreement with observation in non relativistic approximation. He wrote up this work and published it in 1926 and in this delayed manner Schrödinger's wave equation was presented to the world.

3. The Advent of Wave Mechanics

As mentioned earlier, the year 1926 was a landmark in the history of quantum mechanics. In that single year Schrödinger published a total of eight papers. The first to come was on the energy levels of the ideal gas; next came the famous series of five papers in *Annalen der Physik* containing the formulations of both the time-independent and time-dependent Schrödinger equations, application to the hydrogen atom, time-independent and time-dependent perturbation theory with applications and the equivalence of wave mechanics with Heisenberg-Born-Jordan quantum mechanics which had been developed a year earlier. Thus this series encompassed the whole of won relativistic quantum mechanics without spin, as it stands even today. A succeeding paper contained applications to real systems like atoms and molecules and in the last paper of that year he introduced the coherent states to arrive at a macroscopic description starting from his microscopic mechanics.

The first communication in the series entitled "Quantization as an eigenvalue problem" in *Annalin der Physik* [7] starts with the following introductory paragraph "In his communication I should first like to show on the basis of the simplest cases of the (non relativistic and unperturbed) hydrogen atom that the usual quantization procedure can be replaced by another condition in which there is no longer any mention of 'integers'. On the contrary, the occurrence of integers follows in the same natural way as, for instance, in the case of the number of nodes of a vibrating string. The new form is capable of generalization and is very closely connected, I believe, with the true essence of the quantum laws". Schrödinger then introduced the Hamilton-Jacobi equation $H(q, \partial s/\partial q) = E$ and looked for a solution which is separable in the individual coordinates q. Writing $S = K \ln \psi$, where K is a constant with the dimension of action, separability demanded that ψ be a product of functions, each for one q. Since, H is quadratic in $\partial s/\partial q$, the H-J equation assumed the form: quadratic form in ψ, $\frac{\partial \psi}{\partial q} = 0$, and instead of trying to solve this equation for ψ, he sought for 'such functions ψ, real over the whole configuration space, unique valued, finite, continuous and twice differentiable which make the integral of the quadratic form, just mentioned, extended over the whole configuration space an extreme. This variation problem immediately yielded the corresponding Euler-Lagrange Equation now called, the Schrödinger equation, on neglecting a surface term. For bound systems this caused no problem because ψ itself is zero at infinity; scattering states, however, needed a supplementary condition in that the variation $\partial\psi$ vanish at large distances. The Schrödinger equation for the hydrogen atom was next taken up and after the usual separation of the angular part as spherical harmonies, he proceeded to deal with the radial equation by the method of Poincare and Horn. Following a detailed analysis he showed that the radial equation has solution of the required property for $E<0$ only for certain discrete values of E given by the Bohr formula and thus identified the constant K with $h/z\pi$. For $E>0$, on the other hand, a continuous spectrum existed. He also gave the formula for the bound eigenfunctions and an estimate of the site of the atom by comparing with the elliptic orbits of Sommerfeld for the same angular momentum.

In the second communication Schrödinger came back to the variational problem introduced in the beginning of the first communication. Drawing on the analogy between Fermat's principle in geometrical optics and Maupertuis principle in classical mechanics, he argued for a wave process in configuration space (q-space) underlying classical particle motion. In the "ray optics limit" this wave process whose phase is given by the Hamilton's principal function (S), disappears. He then proceeded to calculate the velocity of the surfaces of constant phase i.e. the phase velocity of the wave and found it in disagreement with the particle velocity. However, the velocity of a wave group with frequencies lying within a small range, agreed with that of the particle. He concluded that this required the q-space to be dispersive as also "optically inhomogeneous but isotropic". The failure of classical mechanics in the atomic domain was, therefore, to be accounted for in the same way as the failure of geometrical optics with "obstacles and apertures no longer large compared to the actual finite wavelengths". With this general discussion behind him, Schrödinger next dispatched with case the harmonic oscillator problem ; the eigenvalues and eigenfunctions were provided and instead of giving a detailed solution of the differential equation as was done in the Coulomb case he referred the reader to Courant and Hilberts book, 'Methods of Mathematical Physics'.

Thus it was that through these papers Schrödinger laid the foundation of wave mechanics. Written in an easy and discoursive style they still retain their flavour and, in my opinion, could still be adopted as a text in an introductory wave mechanics course. □

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SCHRÖDINGER'S SPECULATION ON THE NATURE OF THE CARRIERS OF THE HEREDITARY INFORMATIONS*

KAMALES BHAUMIK**

Erwin Schrödinger, one of the greatest physicist and thinker of the twentieth century, was born in an age when science was not strictly compartmentalised in various disciplines. He, in his own words, had a "keen longing for unified, all-embracing knowledge". It is, therefore, not surprising that he spent a considerable amount of time in the later part of his life to ponder over the problems of biology. The question that intrigued him very much was the following : "How can the events in space and time which takes place within the spatial boundary of a living organism be accounted for by physics and chemistry ?"

Haunted by this question Schrödinger undertook a serious study of contemporary biology for about a decade and then delivered a series of lectures to a large audience under the auspices of the Institute at Trinity College, Dublin in February, 1943. A year later, based on these lectures, a book entitled "What is life ?" was published by the University Press of Cambridge. Soon after its publication, the book caught the attention of a large number of scientists across the disciplines, ranging from Physics to Psychology. It is perhaps one of the most widely read monograph in science and it has invited quite contradictory criticisms from its readers. Some hail this book as the masterpiece, which has provided a turning point for the biological research, whereas there are others who believe that the book is nothing but an "ensemble of tautological statements". The purpose of the present lecture is to provide a cohesive summary of the book before the audience.

Many people believe that the strangest puzzle of the living system is that the organisms follow an well-organised deterministic path despite the fact that the processes of life are inherently controlled by sets of chemical reactions, which are probabilistic in nature. According to Schrödinger, the solution of this puzzle lies in the very nature of the statistical processes. A living organism consists of millions of cells and any particular development of the living system is carried out by the chemical reactions which involve very large number of molecules. The law of large number in the statistical theory states that the probabilistic error in any phenomenon goes inversely as the square root of n, where n is the number of units participating in the phenomenon. In the light of this law, it is, therefore, not difficult to understand why the living system follows on the average a deterministic course. According to Schrödinger, the strangest puzzle of life lies elsewhere. It is known that there are processes which are extremely crucial for the existence of life, but surprisingly these processes are controlled not by millions or billions of molecules but by only a few molecules, which are also not very large in their structures. As an example, he mentioned the molecules which transmit the hereditary characters from generation to generation. How in a random thermal environment these molecules maintain their permanence ? Are these molecules formed of highly stable bonds, so that their structures are not perturbed by thermal agitation ? If it is so, then how these molecules undergo spontaneous mutation ? How these molecules store and transmit informations ? What is the structure of these molecules, which are the bearers of hereditary characters ? Almost the entire book has been devoted on the discussion of these questions. (The last two chapters of the book deal with some other topics, which will not be discussed here).

Now-a-days everybody knows that the molecules, which are the carriers of hereditary characteristics, generally are DNA (Deoxyribonucleic Acid). DNA is a double stranded polymer with a double-helical structure. The backbone of the polymer consists of repetitive sugar-phosphate chain. The hereditary informations are contained in the sequence of nucleotides attached to this backbone. Depending on the stimulus received by the cell from its environment, appropriate portions of the DNA helix get uncoiled. The message coded in the uncoiled portion can be read, retrieved and realised in the formation of enzymes which in turn initiate a chain of chemical reactions to achieve the desired response appropriate for that stimulus. The structure and functions of DNA are already understood to a great extent and the picture is becoming clearer with the development of molecular biology.

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However, these informations were not at all known at the time when Schrödinger delivered his lectures. It is surprising that inspite of that paucity of knowledge, he was able to predict the nature of these molecules from the viewpoint of theoretical physics and his predictions were eventually proved to be correct. In the remaining part of the present lecture we shall recollect the informations, which were available to Schrödinger and shall discuss his methodology of prediction.

By 1943, classical genetics had become a well developed discipline and the works on Radiation Biology were already on progress. These works as well as the devoted and pains-taking experimental research on biology for about a century revealed that (a) hereditary informations are contained in the chromosome, which are some structures always occurring in pairs within the nucleus of the cells, (b) all the cells of an organism contain the same information though they perform different functions depending on thier location within the body, (c) in case of cell-division (mitosis) these chromosome-pairs get duplicated, (d) in case of sperm cells and egg cells, only one member of each pair of chromosomes are randomly seggregated within the nucleus of the cells, (e) in the fertilized egg one member of each pair of chromosomes are contributed by each of the parents and thereby the traits of both father and mother are transmitted to the offspring, (f) any particular hereditary trait is controlled by a particular portion of a particular chromosome and if that particular portion is perturbed by any physical or chemical mechanism the trait is either lost or altered, (g) if after the above-mentioned perturbation the organisms still remain viable and they are bred pure, then the offsprings bear the characteristics of the mutated trait, (h) apart from these induced mutations, some mutation also can occur spontaneously.

Based on these informations Schrödinger observed that the carriers of the hereditary characters are some long molecules, whose specific portions (hereafter to be called as genes) controll the specific traits as expressed by the organism. Then he asked the following four important questions.

(1) What is the size of a gene? (materialistic realization of hereditary characters).
(2) How most of the traits of an organism remain unchanged from generation to generation? (question of permanence).
(3) How occasionally offsprings are born with some characteristics, which is completely different from either of their parents and if these offsprings are bred pure, why the particular characteristic is inherited by the future generation ? (problem of mutation).
(4) How the informations are coded within the gene ? (Structure of gene).

We shall now discuss these questions sequentially.

Size : The size of a gene can be estimated as follows. For the species (which has been well-studied by the geneticists) one may obtain the total length of a chromosome and the total number of traits associated with that chromosome. Dividing the former by the latter and multiplying the quotient with the measured cross-section of the chromosome one may get the average size of a gene. For a normal-sized cell, the average volume of a gene comes out to be a cube of side 300 A, which means that the number of atoms contained within the gene is of the order of a million.

Permanence : It may be observed that one million atoms is too small a number to average out the statistical fluctuations. The atoms are, of course, not in a free form but they must exist in molecular forms. Even then, the physiological temperature at which the genes are kept, is high enough to cause random thermal perturbation on this molecular structure. But the informations are kept fairly undisturbed for a surprisingly long time. According to Schrödinger the answer to this problem lies in Quantum Mechanics. A molecular structure cannot possess continuous energy levels, but rather a few discrete levels are permitted. A "quantum jump" from one permitted level to the other is possible only when the difference of energy (say W) between the two levels is supplied from outside. If W is very small the fluctuation in thermal energy (whose average is kT, where k is the Boltzmann constant and T is the temperature of the environment in the absolute scale) may be able to effect the change. But if the molecular structure is such that it requires very large amount of energy to go from its present stable configuration to the nearest stable configuration or in other words if the ratio W/kT is very large, then any rearrangement of the molecular structure other than its present form will become a very rare event. One can, in fact, calculate the "time of expectation (t)" i.e. the average amount of time needed to change the configuration of a molecular structure from the estimate of the ratio of W/kT. It may be shown that if this ratio is 30, then t is of the order of one-tenth of a second, whereas if the ratio is 60, then t is of the order of 30,000 years. In the light of quantum mechanics, therefore, it is not difficult to understand how a molecular structure, like gene, can be insured for its permanence against the random thermal perturbations.

Mutation: If gene is such a permanent structure, how then one occasionally observes spontaneously mutated varieties? To explain this phenomenon, Schrödinger speculated that within the molecular structure of the gene there are certain locations, where a local rearrangement of atoms to another stable configuration may not require a very high amount of energy input. The "time of expectation" of such events may be quite large but may not be larger than the time-scale of evolution. In such an event the entire molecular structure will remain unchanged excepting a small variation in some particular location, so that the energy of the gene will be practically unaltered. The point to be noted here is that even for this small change in energy, the information content of the gene may get drastically altered leading to a mutation. To have a proper appreciation of this point, one has to understand the mechanism by which the informations are coded in the said molecular structure.

Structure : Since the molecules of the gene store information, the molecular arrangement within the assembly cannot be random. It must be an ordered arrangement. An example of very orderly arrangement is exhibited by the periodic crystal. Are the genes then periodic crystals? The answer is negative, because as Schrödinger has pointed out, all the informations contained in the entire crystal are also contained within its individual units. Thus as far as the infromation content is concerned the large repetitive periodic structure is quite redundant and meaningless. At this stage Schrödinger introduces the concept of aperiodic crystal. These crystals, for example, may have a backbone of perfect periodicity but may have some chains which are not repeated periodically. These non-repeatable side chains may code the informations. These also may act as the loci of spontaneous mutations. Schrödinger concluded that the carriers of hereditary informations are some molecules which are arranged aperiodically*. Genes have a backbone of exactly repeatable structure with some groups of molecules attached to this backbone at regular intervals in a non-repeatable sequence. The entire structure is thus very stable against the thermal perturbation. However, the molecules at side chains, which carry the informations of hereditary characters, can undergo spontaneous changes leading to mutation.

It does not need any elaboration to show that all the predictions of Schrödinger regarding the structure and function of genes have been proved to be correct through future works. It is surprising that he arrived at the proper solution of the problem just from a theoretical exercise and without performing a single experiment in biology. It must be regarded as a marvellous piece of theoretical work.

Two more comments must be made before concluding this lecture. It is true that Schrödinger's conjecture regarding the nature of genetic material influenced the contemporary biologists? Perhaps not or at least there is no such recorded evidence to my knowledge. His book has no doubt inspired many people to cross their own boundary to jump into the research in the biological sciences. But, unfortunately, the hard-core biologists had hardly got any opportunity to appreciate his work. The second comment that I would like to make is about the attitude of Schrödinger to learning biology. This point is important in view of the fact that many of us who are

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***His ideas regarding the structure of gene are dispersed throughout the book. If these ideas are properly collected together, one can obtain the following definition.**

involved in inter-disciplinary researches, also suffer from the same defective attitude. It is evident that Schrödinger undertook a thorough study of the contemporary literature in biology. But it appears that he hardly had any interaction with the proper people in the field other than with some physicist-turned-biologists. Had he done so, he would have known that by the time he was delivering his lectures, nucleic acid was already identified by the biochemists as a prime suspect for carrying the hereditary informations. It can be said without any hesitation that if Schrödinger, with his analytical ability, had collaborated with relevant experimentalist, the discovery of DNA would have been accelerated and he would have no need of making comments like "It (i.e. genetic material) is probably a large protein molecule".

To conclude, we get two lessons from this study. A person, who is intelligent enough, can make positive contribution in any other field in which he gets interested. Also a person, however intelligent he may be, cannot make a revolutionary change in a new field unless he interacts with the proper persons who are already working in that field. ☐

INDIAN GLYCERIN AND LACUNAE IN RECOMMENDATIONS OF THE LENTIN COMMISSION

R. N. CHAKRAVARTI*

IN the course of barely two and a half weeks, from January 21 to February 7, 1986 there were 14 deaths, all due to administration of glycerin at the famous J. J. Hospital, Bombay as the drug actually used was later established to contain mostly sorbitol and the highly toxic diethylene glycol with a 'dash of glycerine'. In view of so many deaths, one after another, during the short period, the right step was taken by appointment of Hon'ble Mr. Justice B. Lentin, Judge of Bombay High Court, as Head of the Commission of Inquiry, the terms of reference being— 'Deaths of Patients in J. J. Hospital at Bombay in January-February 1986 due to Alleged Reaction of Drugs'. The letter of assent of the President of India dated 18.3.86 reached Mr. Lentin on 24.3.86 and the final Report in the printed form was published in March, 1988. It covers pp. viii, 289. Chapter XVIII on Conclusions covers pp. 275-283, and the last Chapter XIX on Recommendations covers pp. 284-289. Both these valuable chapters are presented sectionwise in a systematic manner. The time taken in bringing it out is well-worth the purpose as this invaluable document will remain as a very important source of inspiration and guidance for future investigators of such highly deplorable cases of negligence, greediness, corruption and interferences from the top, besides the recommended corrective measures for proper drug control and administration of drugs.

There are, however, some lacunae, in the Recommendations, which are understandable especially as Mr. Lentin was concerned with the 14 cases of deaths from toxic effects of the spurious (not even suitable for grading as— highly adulterated) glycerin, although he really reached the root— the source of the raw material used in the drug formulation. Had he gone a little deeper, he might have enquired about the actual manufacturers who market the properly labelled GLYCERIN I.P., the basic drug involved— which should have been used but not used. *It would be useful if the Central Government circulate a list of manufacturers of labelled GLYCERIN I.P.* Normally the Drug Control authorities use practically all their efforts in the domain of the drug formulations and not so much on the basic drugs used in the formulations. Proper control over the manufacture of the basic drugs leaves much to be desired of, although both the drug formulations and the basic drugs are well-covered in the Indian Drugs Act and Rules and the Indian Pharmacopoeia. One will appreciate the importance of the above statement if one tries to find out in the markèt a drum of labelled GLYCERIN I.P. The Drug Control authorities should not only try to pin point the defects of the dosage forms of drugs placed in the market for use of patients, but should also try to help the manufacturers of the dosage forms in having proper Control over the manufacturers of basic drugs for maintenance of proper standard of the basic drugs including some curb on *bag to bag* and *drum to drum variation*, which sometimes poses a great problem during manufacture of the dosage forms.

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The following portions are quoted from the Report (pp. 129-132):

> '50. In this conspiracy Jethalal Soni, proprietor of Ganesh Chemicals also has a part ...'
>
> '62. Jethalal Soni's trade practices are not entirely beyond reproach. ...'
>
> '65. This brings me to the *nature of the product manufactured by Jethalal Soni.*'
>
> '66. Jethalal Soni carries on business in the name and style of Ganesh Chemicals Corporation as the sole proprietor since the past 7 years. He is a B.Sc. in Chemistry from the Gujarat University. He manufactures and supplies only what he calls "chalu glycerine" which is a substitute for glycerine I.W.'
>
> '67. Jethalal Soni manufactures glycerine industrial grade and glycerine textile grade. The former is used for manufacture of writing ink, stamp pad ink, typewriter ribbons and carbon papers and metal treatment chemicals. The latter is used for textile purposes.'
>
> '68. Jethalal Soni manufactures industrial glycerine by mixing sorbitol, diethylene glycol and pure glycerine For the manufacture of 250 kgs. of industrial glycerine, he mixes 187 kg. sorbitol, 40 kg. diethylene glycol and 25 kg. pure glycerine. For the manufacture of 200 kg of textile glycerine, he mixes 120 kg. liquid glucose, 60 kg. diethylene glycol and 20 kg. water. In textile glycerine, no pure glycerine is used.'
>
> '69. He admitted that his product, be it industrial glycerine or textile glycerine, is unfit for human consumption and would cause death if taken internally, because one of the ingredients is diethylene glycol.'
>
> '72. He purchases drums from hawkers or utilises the drums in which he received the raw material. His 250 kg. drums are painted in red and the lids in white. On the lids he stencils in red paint, one and half inch in length and 5 mm. in breadth, the words "GLYCERINE NOT FOR MEDICINAL USE. NET WEIGHT 250 KG". He claim that his purpose in doing so was to make sure that even by mistake his product would not be used for medicinal purposes'.
>
> '75. He admitted that his product is the result of his own formula not be found in any recognised text book or Merck Index. He admitted that it was to make more money that he invented his own formula whereby his product would be identical to glycerine and yet not be glycerine, by which he meant that the properties of his product would be the same as those of industrial glycerine, namely industrial white. The weight per ml. of his product was about the same as that of pure glycerine, but his product was less viscous than pure glycerine'.
>
> '78. He admitted that his product is cheaper than standard I.S.I. glycerine by half the price and that he mixed sorbitol and diethylene glycol in glycerine and called his product glycerine because the price of glycerine by itself is more than that of diethylene glycol and sorbitol. He also admitted that therefore what he called glycerine manufactured by mixing diethylene glycol and sorbitol with pure glycerine would cost him less than if he were to sell pure glycerine. He also admitted that unless he called his product glycerine, he would not get the same price as he would get merely from the sale of sorbitol or diethylene glycol, and that if his purchasers knew that he was mixing sorbitol and diethylene glycol in pure glycerine, they would not pay him the same price as they would for pure glycerine. When asked why he used glycerine at all in his product, he replied that he did so because he wanted to sell his product as glycerine and that he wanted to sell diethylene glycol and sorbitol in the guise of glycerine. According to him, his product could be called adulterated glycerine'.
>
> '79. He admitted that he never indicated either by any document or on the drums of his product that it was a substitute for glycerine; that he held out his product to be glycerine I.W. and that he did not display his name or address or identify the commodity though required to do so under the Weights and Measures Act professedly out of ignorance of the rules framed under the Act.

It is evident that Soni's product, though labelled as GLYCERINE, contained only about 10% of glycerin (according to his statement)—on the label on the drum there was no mention about name and address of manufacturer, composition of the contents or the uses of the product. "NOT FOR MEDICINAL USE" appears to have been used by him as a shield against application of the Drugs Act and Rules, but is it suitable for use as commercial or technical grade of glycerol, for example, for production of glycerol based chemicals like nitro-glycerine? Can one escape or shirk responsibility by pleading on grounds of ignorance of Weights and Measures Act? Is the product suitable for use in cosmetics or as a food additive? According to 23rd Report of the Joint FAO/WHO

Expert Committee on Food Additives (1980), diethylene glycol is prohibited from using as a food additive. If the Central Government, with its Ministries of Industries, Commerce, Petroleum (and Chemicals?), are unable to stop manufacture of *Soni's Glycerine* and such other spurious or adulterated or sub-standard glycerin, then genuine manufacturers of glycerin may suffer as our such products may be simply called INDIAN GLYCERIN. It is depressing to note from the Report about existence, in the country, of "chalu glycerine", "local glycerine", etc.

Under 'CONCLUSIONS' of the Report, p. 276, III—**Manufacturers, Merchants, Traders and Suppliers,** it is stated:

> '3. The concoction prepared by Jethalal Soni, the proprietor of Ganesh Chemicals comprised mainly of lethal diethylene glycol and sorbitol with a dash of glycerine. It was this concoction which ultimately reached the J. J. Hospital as Alpana Pharma's Batch No. 27.'
>
> '4. Jethalal Soni however did not know that this glycerol would be used as drug'.

Possibly on the above ground there is no mention about Ganesh Chemicals or about Jethalal Soni under 'RECOMMENDATIONS' in pp. 284-289 of the Report. As quoted above, Mr. Soni admitted that his product could be called adulterated glycerin though it is really a mixture of sorbitol and diethylene glycol adulterated with glycerin (10% or *if any*). The product is to be truly designated as *spurious glycerin*. Though in view of the declaration forbidding medicinal use he cannot be held responsible for the 14 cases of deaths at the J. J. Hospital, *if the product with its present label, as on the drum, is put to various uses for which glycerin is used, other than as drugs, it may cause injury and even death to hundreds of people.* It is not clear from the Report whether Mr. Soni has a manufacturing licence for the product, or it is covered by some kind of O.G.L. In case of a manufacturing licence, the manufacture comes under some kind of Control of the Authority issuing the licence. How is it that products are being placed in the market with labels indicating that the contained material is glycerin though containing 'a dash of glycerine' or even none at all, as in the case of Textile Glycerine of Ganesh Chemicals? Are these permissible under the Laws of the country? Will such manufacturers remain immune to penalty and continue to manufacture such spurious products for want of a prosecutor?

In view of the Report, the Drug Control authorities at Delhi appear to have been made somewhat nervous, as a lot of interest is now being taken in devising ways and means for making the monograph on Glycerin I.P. fool-proof by including a suitable test for absence of diethylene glycol. To be frank, such a test comes under forensic science and not under any pharmacopoeia. After all, the drug used is a spurious drug. The 14 deaths were due to use of well over lethal quantities of diethylene glycol. Tomorrow, some one may mix other toxic materials, e.g. tritolyl phosphate with glycerin. Will it then become relevant to include in the monograph tests for absence of such adulterants also? In the case of some drugs there are some limits tests for absence of some toxic materials because such materials are normally present in the crude drugs and/or produced during storage and the limit tests are a necessity to establish proper absence of such related toxic materials in the drug so that it may be declared to be of standard quality. *But with unlimited scope for wilful adulteration,* as in the present case of mixing diethylene glycol with glycerin, *it is difficult to prescribe any fool-proof measure in the pharmacopoeia other than HPLC.*

It may be noted that Mr. Soni, a B.Sc. in Chemistry, admitted that he adjusted the formula of his mixture in such a way that the weight per ml. complies with that for Glycerin I.P. On the other hand, it is highly significant to mention that, of all liquids freely soluble in water and having Sp. Gr. 1.2 to 1.3, glycerin has possibly by far the highest relative viscosity. It is evident from Mr. Soni's statement that he could not raise the viscosity of his mixture to that of glycerin. This property may be considered if at all, though I am not the least interested for inclusion of even this new item in the monograph of Glycerin I.P. Let the sanctity of the pharmacopoeia be maintained instead of opening the flood-gate for inclusion of hundreds of tests for detection of wilful adulteration. On the other hand, porper stress should be laid on taking due care not only with regard to manufacture of the dosage forms but also with regard to manufacture of the basic drugs by the Drug Control authorities.

Lastly, it may be pointed out that sorbitol is not to be classified as a lethal poison in spite of the following portion of the Report, pp. 132-133:

> '81. ... .. he used an infinitesmal percentage of pure glycerine and a preponderantly large percentage of the lethal poisons like diethylene glycol and sorbitol, ...' □

Notes and news

Garlic juice as immuniser

The Bangladesh Jute Research Institute (BJRC) has achieved a major breakthrough in the control of pests without pesticides, according to its Director-general Mosharaf Hussian. If jute seeds are mixed with garlic juice before sowing, raw jute plants are virtually immunised from the insects and pests. Two entomologists—Nilufar Ahmed and Kishwar Sultana—have been working on this experiment since 1979. After a series of trials, they have reached the conclusion that the garlic treatment is a very reliable method of immunising jute plants.

The method of mixing garlic juice with seeds requires no technological innovation. About 7 gm of garlic would be needed for 1 kg of seeds to be sown. At first, the garlic would have to be crushed into granules and the juice thereof is to be smeared with the jute seeds. Thereafter, the juice-smeared seeds are dried in the scorching sun and allowed to be cooled before being preserved in an earthen or tin pot for 2-4 weeks. The pot must have a lid so that the seeds are not attacked by insects for at least 2 weeks and then sowing can be done.

The two researchers have noticed that the pest attack on jute plants are somewhat congenital, as the Jute seeds harbour in them many types of pests. As such, the garlic treatment kills those pests in the very beginning. The BJRC chief, in welcoming the successful research efforts of the two entomologists, has remarked that the seed pre-treatment with garlic juice has the potential of saving about Taka 1.5 billion worth of foreign exchange per year.

Throughout the world, entomologists have opined that garlic has pesticidal properties and there are trials on the possibility of applying garlic as an alternative to the pesticides. There is a global protest against the use of synthetic pesticides as the propensity to use them beyond the threshold limit is greatly in vogue, thus causing various kinds of diseases affecting the gastro-intestinal and respiratory tracts. Incidence of stomach and liver cancer due to pesticides entering the food chain has been strongly inferred by a good number of researchers. The BJRC entomological breakthrough will be welcomed by agricultural scientists and environmentalists.

The Statesman

Disease detectives

If any one American institution can claim to be the family physician of the nation, it is the Centers for Disease Control (CDC) at Atlanta, Georgia. It embraces virtually every aspect of health and health education—from venereal diseases to leukemia and other types of cancer, smoking, family planning, nutrition and vaccination.

CDC employs more than 4,000 persons, half of whom are based in Atlanta at any time. Others may be posted overseas or assigned to field stations in the country. To carry out its diverse functions, CDC is organised into six divisions : infectious diseases; environmental health; health promotion and education; prevention services; occupational safety and health professional development and training.

CDC is a laboratory of last resort, deluged each year with more than 170,000 specimens from all corners of the globe—diseases in need of diagnoses. It is a zoo-keeper, riding herd on quartined cultures of deadly viruses. Some, like small pox, are extinct. Others—the Lassa and South American haemorrhagic virus, for example—still require to be eliminated. With its massive serum banks containing more than 25,000 samples of every kind of disease, CDC is USA's collective memory of recent human afflictions—each sample cross-listed under more than 250 categories. Its computer has one of the largest collections of tapes, holding a plethora of data and gathered in the course of its search for answers to many health riddles. Since its scientists work with disease-producing organisms, CDC strictly controls access to its many laboratories. In its Maximum Containment Laboratory, for example, workers must wear pressurised protective garb to avoid introducing organisms into the experiments and to protect themselves from the diseases they may contact from the organisms they are studying.

CDC actively collaborates with foreign governments and international organisations in an attempt to control disease and improve health world-wide. It played a vital role in the massive immunisation campaign, leading to the complete eradication of small pox by the late seventies which, before the advent of modern medicine, regularly killed millions. In a real sense, it is a detective agency, relentlessly varifying and quantifying disease statistics from around this planet. Its purpose is to identify and remove, as far possible, human illness from the surface of the earth. ☐

Span

Heartly News

According to a study, conducted over a period of nearly five years at Boston's Brigham and Women's Hospital, an aspirin tablet, a common pain-killer, taken on alternate days can reduce almost in half the risk of a heart attack.

The study, initiated in 1981 and funded by USA's National Heart, Lung, and Blood Institute (NHLBI), included more than 22,000 male physicians who had never suffered heart attacks or other serious ailments. Half of the physicians took aspirin for nearly five years and the rest received a placebo. There were 104 heart attacks among the aspirin users, five of them proving fatal and 189 heart attacks in the comparison group (including 18 fatal cases). There were also 80 strokes in the aspirin group and 70 among the others. The results indicated that an aspirin taken every other day cut the risk of heart attack by 47%.

Speaking at a press conference, American heart specialists stated that the research provides strong evidence that aspirin will be a major weapon against the number one killer of the United States, cardiovascular disease. "There is little reason to suspect that the biologic effects of aspirin would be different in other populations with comparable or higher risks of cardiovascular disease". Lawerence Cohen of Yale University's School of Medicine, told reporters. "Therefore, it is possible that thousands of individuals may have their heart attack prevented yearly by administration of aspirin every other day. As such, the results of this trial are exciting and have tremendous health implications', he said. However, Claude Lenfant, NHLBI director, cautioned that the general public should not take the findings as an indication that everyone should start using aspirin. A decision to use aspirin to prevent heart attacks should only be made after consulting with a physician. The heart experts agreed that generally anyone with risk factors — such as diabetes, hypertension, high blood cholesterol or a family history of heart attacks—for heart disease should be considered a candidate for routine use of aspirin.

Medical experts believe that aspirin works by inhibiting the aggregation of platelets, a cellular component of the blood responsible for clotting. At the site of a narrowed artery, platelets form a mesh ultimately leading to a clot and totally obstructing the flow of blood through the artery. However, doctors cautioned that aspirin could cause decrease blood clotting too much in some individuals. For example, the investigation showed that there was a small, though not statistically significant, increase in death from strokes among those receiving aspirin. Presumably, the strokes were caused by brain haemorrhages. ☐

Span

Novel method of tree-growing

A University scientist is successfully growing trees in situations where they have never been raised before, in the Negev Desert near Sde Boker, Israel. This achievement by Professor of Geography Aharon Yair is the culmination of his extensive studies of local rainfall, soil, topography, fauna and flora.

Using water-harvesting techniques that Yair developed to exploit areas of special topography and soil, he has succeeded in growing trees in a region of 93 mm annual average rainfall. Water-harvesting for agricultural use is well- known in desert regions. The remains of early Nabatean agriculture in the Negev Highlands are one example of this practice. The ancient Nabateans took run off water in channels from rocky hill slopes to their farms at the valley bottoms. With this system, agriculture was confined to limited areas of bottom soil. However, Yair found that more water was caught at the middle of the slope, just below the rocky outcrops than at the bottom, unlike what was suggested by Nabatean practice.

These experiments of growing trees on rocky desert slopes are the outcome of Yair's long multidisciplinary studies which were carried out in collaboration with David Sharon, Hanoch Lavie and Avinoan Danin of the Hebrew University and an ecologist Moshe Shachak of Blaustein Institute of Desert Research of BenGurion University of the Negev. Doctoral and Master's students also participated in the project.

In 1972, Yair established an experimental site on a rocky ridge near Sde Boker. For a number of years, he studied topics such as the relation between rain and runoff, soil properties and biological activity. His findings suggested that it was possible to expand the cultivated area considerably to include fertile slopes never used before. The bological, hydrological and pedological findings led to the conjecture that the amount of water collected in the fertile belt, between the rocky upper part of the slope and the soil at its base, was equivalent to 250-300 mm of rainfall and would suffice to grow trees in a sector of mere 93 mm yearly rainfall. Most of the runoff from the rocks at the top of the ridge is absorbed in this belt, where it is held in depth without evaporating, available for use by plants. In order to test this conjecture, 300 basin-like furrows specially designed by Yair were dug in this fertile belt with the help from the Jewish National Fund (JNF) and saplings were planted in them, including carobs and pines. The first two years were drought years and the runoff was the sparest for 25 years. The saplings grew well and developed, despite heavy browsing by gazelles and without irrigation, as well as though growing in more northerly (wetter) tracts.

Last January, the JNF unveiled the grave of trees near Sde Boker in a ceremony to mark the Ben-Gurion Centenary celebrations. This shows that trees (and not only shrubs) can be grown in previously untried locations in the Negev Highlands (about 600 km^2) and that a potential for afforestation exists there. Yair is now planning to expand the scope of the experiments and to plant several thousand trees, including those of economic value such as olive trees. □

News from Hebrew University

Fungal parasite to control powdery-mildew disease

Scientists at the University's Faculty of Agriculture in Rehovot have succeeded in isolating a fungus, *Ampelomyces quisqualis*, which is parasitic upon other fungi and which they see as being able to reduce considerably the serious damage to agricultural crops caused by powdery-mildew disease. The study was performed by Abraham Sztejnberg, with the participation of Shlomit Mazar and Sergio Galper, of the Department of Plant Pathology and Microbiology, in collaboration with Norberto Lisker of the Agricultural Research Organisation's Volcanic Institute at Bet Dagan.

Powdery-mildew disease seriously affects the development and yields of fruit trees, grain, flowers and vegetable crops. At present, control of this and similar diseases is carried out using fungicides which are expensive and which tend to pollute the environment.

The scientists succeeded in isolating this fungal parasite from other fungi, growing it in artificial media and receiving a heavy yield of spores in a short time. In experiments in the laboratory, in greenhouses and in the open field, the application of *A. quisqualis* brought a 50% increase in cucumber yield over untreated plants. Combined use of the fungal parasite alongside limited quantities of fungicides induced a 90% increase in the cucumber crop. Recently, an Israeli Company, Biotechnology Applications Ltd., has decided to finance the continuation of this research with the intention of commercialisation. □

News from Hebrew University

Ozone update

As environmentalists had hoped and expected, a historic agreement to protect the earth's stratospheric ozone was signed by delegates of 24 nations last autumn following a year of negotiations. The agreement calls for a freeze on the use of chlorofluorocarbons (CFCs) at their 1986 levels by 1989 and a 50% reduction by 1999. CFCs are the colourless and odourless compounds destroying ozone in the earth's upper atmosphere; this ozone layer shields the earth from demaging ultraviolet radiation. While praising the agreement, environmentalists have also said it does not go far enough to half stratospheric ozone depletion.

Before the agreement can be enacted, it must be ratified by at least 11 nations that are collectively responsible for two-thirds of global CFC use. As of December 1987, the proposed treaty has not been ratified by a sufficient number of nations, although all major CFC-producing countries are expected to endorse the agreement. the United States, while it had not ratified the treaty, became the first nation to take internal steps to implement it. In December, the US Environmental Protection Agency proposed regulations that would require the same freeze and cut-back in CFC use as does the international agreement. These regulations also call for a freeze in the use of halons, another group of chemicals believed to be contributing to the ozone problem. Environmentalists say these regulations, like the treaty, will slow but not stop ozone depletion.

Meanwhile, scientists studying the mysterious ozone "hole" over Antarctica reported in October '87 that stratospheric ozone in that region had reached its lowest recorded level in July and August of the same year. For about a decade, researchers have watched with concern as ozone levels over Antarctica drop dramatically every summer and early autumn. The researchers, who reported last summer's lowest-ever ozone readings, work for NASA, basing their analysis on air and satellite data. A few weeks later, scientists from the National Science Foundation's (NSF) National Ozone Expedition recorded similar results based on observations from the ground. In addition, the NSF data support the theory that CFCs are at least, in part, responsible for the Antarctic Ozone hole, just as they are for the general reduction of stratospheric ozone globally. □

Bioscience

Letters to the editor

Observations on the incidence of aquatic bugs (Hemiptera) in a stocking pond in West Bengal

Aquatic bugs occupy a considerable position in the insect community of fresh water ecosystem. Their interactions with cultivable fishes are well known. The productivity of nursery and rearing ponds are very much dependent on the population factors of the said bugs [1,3,4]. The population incidence of these bugs is subjected to seasonal fluctuations in relation to the several environmental factors[9]. Very limited works have been done on the ecological aspects of the aquatic bugs in Indian closed water system[2,8,9]. From West Bengal no account is available excepting the stray publication [9]. However, the present communication aims at displaying the preliminary observations on aquatic bug population and their ecology in a stocking pond in West Bengal.

The pond selected for study (Rahara, 24-Parganas) was more or less rectangular (30 m x 20 m) with sloping margins. The bottom was made up of peebles, molluscan shells, sand and clay soil. Microphyte vegetation was very poor. Preliminary observation was confined to half-yearly duration from Sep-

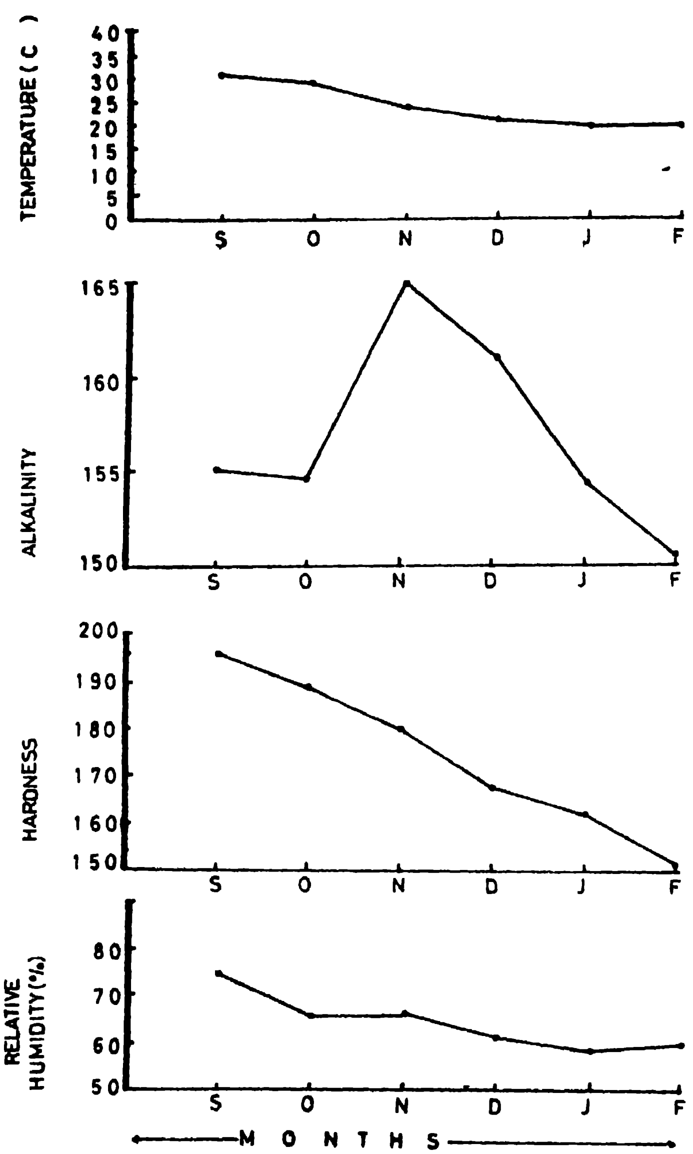

Fig. 1. Showing the distribution of abiotic features prevailing in the pond during 1986-87.

r, 1986 to Feburary 1987, when environmental features appeared in the following ways (Fig.1): temperature—20.00-31.50°C, relative humidity—58.50-74.50%, alkalinity—151.25-165.50 ppm and water hardness 151.00-196.20. Observations were made at fortnightly intervals through netting from 20 randomly selected quadrats were each measured as 100 x 100 cm.

Five bug genera, *Micronecta* (Corixidae), *Notonecta*, *Enithares*, *Anisops* (Notonectidae) and *Gerris* (Gerridae) were found in the samples (Table 1). The *Micronecta* was in a greater volume during Sep-

TABLE 1 : Population incidence (%) of aquatic bugs in West-Bengal during Post monsoon season, 1986-87

Genera	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Micronecta sp.	30.98	20.54	7.05	0	26.35	15.08
Notonecta sp.	22.09	13.18	21.57	13.58	18.39	11.19
Enithares sp.	0	11.73	12.79	29.85	34.97	10.66
Anisops sp.	0	7.54	38.69	32.66	15.08	6.03
Gerris sp.	29.73	16.22	0	28.38	12.16	13.51

tember and then it followed a gradual decreasing trend up to November. In December, the corixid bug was almost absent from the pond. Again, it appeared in January with relatively high population which soon followed by an abrupt fall during Feburary. The family Notonectidae appeared with three genera like *Notonecta*, *Enithares* and *Anisops*. Amongst them, *Notonecta* sp. was seen in greater volume during September which after attaining a little fall attained a second peak during November. A third peak was seen during January. *Enithares* sp. appeared in the pond from October to Feburary, showing a peak incidence during January. *Anisops* sp. could also be found to appear during October which soon attained peak during November and then followed a gradual decrease. The last marked species *Gerris* (Family: Gerridae), though appeared in a greater volume during September, completely disappeared during November. Again, it was seen to reappear during December and presisted up to February with thin population. The relative distribution of these insects (Table 2) in bug community indicates that all five genera could not be found altogether during the period of observation. Amongst them only *Notonecta* appeared throughout the season. Again, the said bug was found to present high population volume followed by *Enithares* sp., *Anisops* sp., *Gerris* sp. and *Micronecta* sp.

TABLE 2 : Relative percentage distribution of insects in bug community during Post monsoon season, 1986-87

Genera	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Average
Micronecta sp.	6.05	2.13	1.32	0	4.89	5.08	3.24 ± 2.42
Notonecta sp.	86.27	73.87	70.68	52.15	62.33	75.36	70.11 ±11.71
Enithares sp.	0	12.30	7.85	21.47	22.23	8.42	12.04 ± 8.58
Anisops sp.	0	6.40	20.15	19.94	8.13	6.09	10.12 ± 8.17
Gerris sp.	7.68	5.34	0	6.44	2.42	5.05	4.49 ± 2.81

The results obtained from the present study revealed the five aquatic bug genera, *Micronecta* (Corixidae), *Notonecta*, *Enithares*, *Anisops* (Notonectidae) and *Gerris* (Gerridae) appeared in the pond with seasonal fluctuations. Amongst them, only notonectid bugs show continuous incidence with a considerable population volume while others (Family : Corixidae and Gerridae) exhibited a periodic disappearance.

Again, *Notonecta* sp. (Notonectidae) appeared as a predominating group in the aquatic bug community. Interestingly, the bugs are seen to exhibit peak incidence at different periods indicating a periodicity in abundance. The said behaviour corresponds with the periodic disappearance (? type of local migration)[5] which may appear to reduce interspecific competition in a common trophic level in the concerned ecosystem[7]. The greater performance of the bug genera during September indicates a further preferential response of the bugs to higher temperature.

Though the present study does not say much about the ecosystem of the aquatic bugs, it is evident that the availability of high temperature and migratory behaviour appeared to be the contributory factors in the predominance of aquatic bugs in a stocking pond. The said contention gains ground with the findings of previous workers[5,6].

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Allelopathic effects of inhibitors from *Cassia* and *Crotalaria* plants on mustard *(Brassica)*

Earlier studies from this laboratory concentrated on the influence of aqueous extract/leachate of certain weeds on the germination and seedling growth of selected test species[1-11]. In order to find out whether more mature phases of plants are affected, inhibitor solutions from leaves of two leguminous weeds—*Cassia sophera* var. *purpurea* Bak. and *Crotalaria pallida* var. *pallida* Ait. — are applied in the form of aerial spray to mustard (*Brassica campestris* var. *dichotoma* Watt.) plants. There is a need to identify interactions between weeds and crops; this aspect can be tackled by spraying extracts from plant-parts, containing high concentration of inhibitors[12], to potted plants of target species. The purpose is to demonstrate the allelopathic effect of a weed extract.

To start with, mustard plants were raised in 30-cm pots, each containing 20 plants. When they were 14 days old, they were thinned down to 10 per pot. Sprays of inhibitor solution from leaves of *Cassia* and *Crotalaria* plants commenced during anthesis of mustard plants and followed on alternate days for 10 days (with a total of five applications). For each treatment, 50 ml of inhibitor solution of two concentrations was sprayed to the above-ground parts of target plants. Just before spraying, the inhibitor solution was prepared by crushing 100 gm of leaf tissues of *Cassia* and *Crotalaria* in a Bajaj mixer with glass-distilled water; it was filtered through Whatman (No. 1) filter paper and the filtrate made 250 ml by adding distilled water for the stock solution (1:2.5) from which 1:5 concentration was obtained by way of dilution. Those plants which were sprayed with 50 ml of distilled water served as the control. There were four pots for each condition. All treated and control pots were placed in the greenhouse. Relevant observations were recorded seven days after the last spray.

The fruit number and fruit length as well as the number of seeds per fruit and per plant were lowered by the spray of both *Cassia* and *Crotalaria inhibitors* (Table 1). However, the impact of higher (1:2.5) and lower (1:5) concentration of the inhibitor was evident in the case of seed output of the treated plants. The seed weight decreased only in plants receiving the spray of higher concentration of *Crotalaria* inhibitor. While the flower production was significantly reduced by the two concentrations of *Cassia* inhibitor, it was so for *Crotalaria* inhibitor at higher concentration.

Since the fruit number and seed number of a crop plant are uniformly inhibited by the two weed extracts, it follows that the growing condition of mother plants (during anthesis) is important when the aerial spray of inhibitors is tried. Further work would be worthwhile by planting seeds from such treatments and observing the changes in the offspring. As to the chemical composition of inhibitors from *Cassia* and *Crotalaria* leaves, work is in progress and the details will be published elsewhere.

TABLE 1 : Mustard plants during anthesis affected by spray of *Cassia* and *Crotalaria* inhibitors

Growth paramcter	Control	*Cassia*		*Crotalaria*	
		1 : 2.5	1 : 5	1 : 2.5	1 : 5
No. of flowers/plant	47.20 ± 2.35	38.70 ± 1.79**	40.00 ± 1.75*	40.40 ± 1.41*	41.80 ± 2.13
No. of fruits/plant	18.60 ± 1.97	6.30 ± 0.49***	8.10. ± 0.52***	7.00 ± 0.72***	8.40 ± 0.59***
Length of fruit (cm)	4.90 ± 0 23	3.50 ± 0 05***	3.80 ± 0 20**	3.40 ± 0.14***	3.20 ± 0.17***
No. of seeds/fruit	15.20 ± 0.64	8 60 ±0.66***	9.60 ± 0.47***	9 20 ± 0.71***	9.30 ± 0.98***
No. of seeds/plant	282.70 ± 30.09	60.40 ± 4.75***	69.60 ± 4.52***	65 10 ± 6.79***	77.20 ± 5.52***
Weight of 100 seeds (gm)	0.31 ± 0.04	0 22 ± 0.12	0 28 ±0.11	0.09 ± 0.01***	0.21 ±0.08

* t value significant at 5% level ' t value significant at 1% level ' t value significant at 0.1% level

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Qualitative detection of chlorogenic acid from sunflower deoiled cake—a novel approach

The Sunflower is being cultivated in various parts of the world for its edible oil. The sunflower deoiled cake contains 40 - 50% proteins, 10% carbohydrates, 1% fat, 3% fibre and ash, and 4.0% chlorogenic acid[1]. About 30% of chlorogenic acid is bound covalently with proteins while the rest 70% is linked with proteins by weak interactions like vander Walls forces, hydrogen bonding and electrostatic interactions[2,3]. Many methods are available for detecting and separating chlorogenic acid from proteins of the Sunflower deoiled cake[2-5]. A method using titanium salt is developed for qualitative analysis of chlorogenic acid.

The sunflower deoiled cake is obtained from the local market. The cake is ground into the powder state and filtered through 40 mesh sieve. In glass stoppered bottle 1 gm of above cake is soaked in dist. water (1:7) cake water ratio and pH is adjusted to 9.0 ± 0.1. The titanium chloride (1 molar solution) is added to the slurry, (at a ratio of 1:1000 parts metal salt : slurry) and is stirred for 30 minutes and then centrifuged. The orange golden yellow coloured supernatent is collected. The extraction step is repeated three more times to remove all available chlorogenic acid.

The drops of golden yellow coloured supernatent solution and solution of titanium salt with chlorogenic acid free protein from sunflower deoiled

30x magnification. It was observed that supernatent clearly showed golden yellow coloured chlorogenic acid is linked with white coloured proteins. The chlorogenic acid free protein showed only white colour. The mechanism of complex formation of chlorogenic and titanium salt is being elucidated.

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Effect of *Azospirillum* inoculation on onion

Substantial growth and yield increases in various crop plants have been reported due to inoculation with the diazotrophic bacterium[1-6] *Azospirillum*, a common oil and root inhabitant. To study the effect of *Azospirillum* inoculation on the yield of onion (*Allium cepa* var. Aggregatum Linn.), a field experiment was conducted in randomized block design with six treatments and four replications during the rabi season of 1981-82. Plot size was kept 4 x 5 m and a spacing of 45 x 10 cm was adopted in ridges and furrows system. Recommended fertilizer schedule (30 kg N, 60 kg P and 30 kg K per ha as basal) and irrigation practices were followed. Onion variety CO_2 was used as test crop. Peat based *Azospirillum* inoculant (containing 2.8×10^9 cells per g dry weight) was used at the rate of 100 g per 25 kg of onion bulbs. Regular cultural practices were carried out uniformly in all the plots. Bulb yield was recorded after cleaning and drying under shade for 4 days soon after harvest.

Results indicated that *Azospirillum* inoculation significantly increased the yield of onion at 50, 75 and 100 per cent of fertilizer nitrogen and the yield increase varied from 18.9 to 20.6 per cent over respective uninoculated control. *Azospirillum* inoculation with 75 and 100% of fertilizer nitrogen application recorded significantly higher yield than all other treatments. However, there was no significant difference between the yields obtained from treatments receiving graded levels of fertilizer nitrogen alone. This leads to the suggestion that the production of plant growth promoting substances[7] apart from the fixation of atmospheric nitrogen by *Azospirillum* might have played an important role for the augmentation of onion yield in this experiment.

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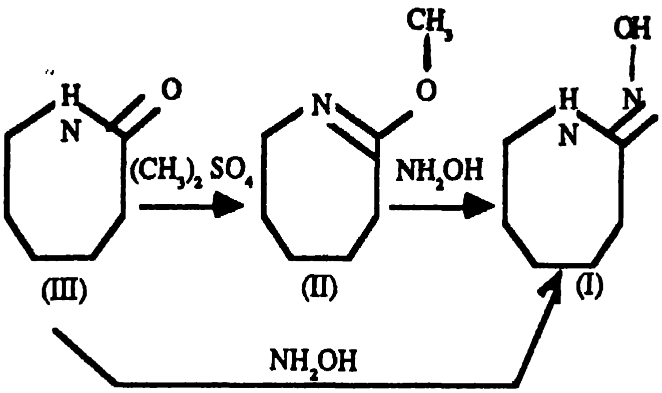
Studies on the synthesis of Amidoxime : Synthesis of Hexahydro-2H-azepin-2-one oxime

Oximation of an aldehyde and ketone have been thoroughly studied by number of scientists. Oximation of dicarboxylic acid amides have been reported by Lazennec[1] and Spoerri[2] and shown the formation of hydroxamic acid and S-isoxazolone, respectively. Amidoxime formation were reported by Russell[3] and Hans[5] from corresponding thioamide. Since, many cyclic amide oximes are reported as fungicide, nematocide[4,6,7] and useful for metal extractions, the present investigation was undertaken.

Hexahydro-2H-azepin-2-one oxime, I, was prepared in nearly the quantitative yield by condensing 3, 4, 5, 6-tetrahydro-7-methoxy-2H-azepine, II, with Hydroxylamine Hydrochloride. The II was prepared by condensation of Hexahydro-2H-azepin-2-one, III, with Dimethyl sulphate. The II was reported in literature[5,8] and prepared by phosgenation of III and subsequently treated with methanol. The formation of II was confirmed on the basis of spectral data and by its boiling point[5,9]. The ir absorption at 1665 CM^{-1} for >C = N– and at 1120 CM^{-1} & 1320 CM^{-1} for –C– O–. The structure of I was confirmed by nmr & ir. The ^{1}H nmr, CDCl$_3$ for I revealed δ 1,5-1.9 (6H, broad singlet, – (CH$_2$)$_3$–), 2.2-2.45 (2H, triplet [not resolved properly and seems to be a broad singlet], –CH$_2$– at 6 position), 3.1-3.4 (2H, multiplet [not resolved properly and seems to be a broad singlet], –CH$_2$– at 2 position), 5.45-5.9 (1H, singlet, = N-O-H), which is disappeared by D$_2$O exchange and 7.95-8.3 (1H, singlet, >N-H), which is disappeared by D$_2$O exchange. The ir has showed characteristic stretching frequences at 1660 CM^{-1} for >C=N–, at 3380 CM^{-1} and 1490 CM^{-1} for –N–H, 1430 CM^{-1} & 1190 CM^{-1} for –C–N– and at 3220 CM^{-1} for bonded –OH.

The preparation of I was attempted by direct condensation of III with Hydroxylamine Hydrochloride in the presence of polar solvent (like water, methanol, etc.) and a proton acceptor (such as NaOH, Na$_2$CO$_3$, pyridine). The reaction product has shown deep blood red coloration with Fe^{+3} salt, suggests the formation of I, which could not be isolated.



Product could not be isolated

3, 4, 5, 6-Tetrahydro-7-methoxy-2H-azepine, II : A mixture of III (0.1mole, 11.3 gm), purifide Dimethylsulphate (0.15 mole, 14.1 gm), anhd. Na_2CO_3 (0.15 mole, 16.0 gm) and acetone (150.0 ML) was refluxed on water bath with stirring for 16-20 hr. The solvent was distilled off and the residue was poured into 250 ml ice-water. The product was extracted with three 20 ml portions of chloroform, dried over anhd. Na_2CO_3. After the removel of the solvent the product was distilled under reduced pressure, 52.0-53.0°C at 18 mm to yield 2.5 gm (20.0%)

Hexahydro-2H-azepin-2-one oxime, I : A mixture of II (2.5 gm), Hydroxylamine Hydrochloride (1.54 gm) and Sodium bicarbonate (1.85 gm) in 20.0 ml methanol was refluxed with stirring for 15.0 hr. After the removal of the solvent the product was poured into 50.0 ml water and extracted with Chloroform. The solvent was evaporated to yield 2.3 gm crude I, which was recrystallised from acetone to give 2.25 gm white leaflets, m. p. 165-165.5°C.

The elemental analysis :

Calculated : C 56.25%, H 9.375%, N 21.87%.
Found : C 56.13%, H 9.29%, N 21.8%.

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Influence of dissolved oxygen in survival and transport of culturable carp seeds

Although studies[1-3] on the tolerance of fish seeds to various levels of dissolved oxygen are available, works relating to the influence of oxygen in the survival of culturable freshwater Indian and Chinese carp seeds especially under hypoxic conditions are wanting. The present investigation, first of its kind was hence attempted to find out the levels of dissolved oxygen during asphyxiation and 50% mortality with a view to estimate the packing density of these seeds in their transportation towards aquaculture purposes.

Healthy seeds of the culturable freshwater carp species viz., *Catla catla* (2.4 - 3.5 g), *Labeo rohita* (2.7 - 3.5 g), *Cirrhinus mrigala* (2.4 - 3.1 g), *Hypophthalmichthys molitrix* (2.5 - 3.0 g), *Ctenopharyngodon idella* (2.9 - 3.8 g) and *Cyprinus carpio* (2.2 - 3.5 g) were collected from the nursery and acclimated for a period of 72 hrs in a glass aquarium containing well aerated water. The seeds were fed with groundnut oilcake powder/plankton. Prior to the experimentation, the seeds were starved for 72 hrs in-order to evacuate their gut contents completely. The respiratory rate of the seeds of the experimental chambers was studied following the method of Job[4]. From each species, a total of ten seeds were subjected to a hypoxic and death phases under an ambient temperature of 28 ± 0.05°C. The dissolved oxygen content of the media of the experimental chambers was estimated following standard Winkler's method[5]. All the experiments were repeated thrice and the average values were taken into account.

The dissolved oxygen concentration during asphyxiation and 50% mortality are shown in Table 1.

TABLE 1 : Dissolved oxygen levels and duration of asphyxiation and death in different species of carps

Species	Oxygen at asphyxiation (ppm)	Oxygen at 50% mortality (ppm)	Time at asphyxiation (minutes)	Time at 50% mortality (minutes)
Catla catla	1.73 ± 0.02	1.60 ± 0.05	35.8 ± 1.8	36.5 ± 1.1
Labeo rohita	1.71 ± 0.01	1.59 ± 0.02	34.3 ± 2.7	41.0 ± 2.2
Cirrhinus mrigala	1.79 ± 0.02	1.65 ± 0.02	34.8 ± 2.1	42.0 ± 4.9
Hypophthalmicthys molitrix	1.61 ± 0.06	1.52 ± 0.02	37.0 ± 1.7	36.2 ± 0.9
Ctenopharyngodon idella	1.65 ± 0.05	1.54 ± 0.01	35.3 ± 1.5	39.7 ± 1.3
Cyprinus carpio	1.59 ± 0.03	1.43 ± 0.02	39.6 ± 1.4	45.2 ± 1.8

It is worth mentioning here that there was no significant difference in the oxygen concentration both at asphyxiation and 50% mortality in the seeds of the different species.

The statistical treatment of the data relating to the asphyxiation and 50% mortality levels showed 1.98 and 1.76. The calculated 't' values were not significant as evident from the table values at t. 0.05 for 4 d.f. (t = 2.776). In this study, the ambient oxygen concentration of the water at 40% saturation was found to be 5.5 ppm (714 mm Hg at 29 ± 2°C) and the seeds were found to be essentially aerobic. However, when they were allowed at hypoxic levels (1.7 ppm) for a period of 36 minutes (vide Table 1), they showed symptoms of asphyxiation. Further retention of the seeds in the same hypoxic level for another four minutes lead to 50% mortality, the dissolved oxygen concentration of which was 1.6 ppm. Jhingran[6] stated that the lethal levels of dissolved oxygen for grass carps and silver-carps were fluctuating between 1.0 and 2.8 ppm. Therefore, it is evident that consumption of oxygen by the seeds is mainly dependant on the dissolved oxygen content of water.

In this study, the reduction in oxygen consumption by the seeds at asphyxiation could be due to their respiratory dependance and not due to changes in activity. Mortality of fish seeds which was mainly due to the depletion of oxygen during transport is not uncommon. As fish seeds are inviably transported to culturable sites from the fish breeding/collection centres, the duration of their transport and the dissolved oxygen content of the media at the time of packing, the basic criteria which are to be considered by the fish farmers. Extensive studies on this line would throw more light on this aspect.

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Solar energy-conserving efficiency of intercropping systems

Intercropping or the grwoing of two (or more) crops simultaneously on the same piece of land in rows with a definite geometrical proportion is an age-old practice of farming in India. It has been realised that intercropping can give higher yields than growing of a single crop alone (sole cropping), better use of growth resources being the major cause of yield advantage[1]. This communication deals with solar-energy utilization efficiency by four species, cultivated as either sole crops or in intercropping systems.

The present investigation was conducted during 1981-82 at the Marathwada University Botanical Garden with Sorghum [*Sorghum bicolar* (L.) Moench, PC-6], maize (*Zea mays* L., Ganga Safed 2), cowpea [*Vigna unguiculata* (L.) Walp, Pusa Dofasli] and dolichos [*Lablab niger* (syn. *Dolichos lablab* L., local]. The crops were cultivated on 16.5 m^2 plots in rows, 30.5 cm apart. Sole cropping constituted the cultivation of either sorghum (S), maize (M), cowpea (C) or dolichos (D) alone in all rows of a plot. The intercropping combinations included cultivation of sorghum or maize with either cowpea or dolichos (S+C, S+D, M+C, M+D). All intercropping combinations contained the two component crops in 1:1 proportion, sown in alternate rows. The cultivation and harvesting methods were the same as given in an earlier paper[2].

The dry matter (DM) yield of crop from either sole- or intercropping system was expressed as g/m^2/day and was considered as net above ground productivity. The energy content was estimated following O'shea and Maguire[3]. The solar energy conservation efficiency of a cropping system was computed according to Sharma[4]. Net primary productivity in terms of calories was worked out by multiplying aboveground dry matter productivity with caloric value of the plant material. The caloric value thus obtained per cm^2 of land was divided by photosynthetically active radiation (PhAR) available during the growth period. The PhAR was taken as 47% of the solar radiation received on the basis of energy data as reported by Khan[5] at the nearest station.

Energy-conserving efficiency is the ratio of output of calories captured by vegetation to the input (solar radiation), in an unit area over a certain length of time[6]. Table 1 gives information on assimilation of PhAR by sole- and intercropping systems. All intercropping systems resulted in higher production in terms of dry matter and energy. Cultivation of sorghum with cowpea and that of maize with dolichos conserved solar energy more eifficiently than that of the cultivation of sorghum or maize alone. The energy-conserving efficiency of shorghum + cowpea intercropping system was maximum, being 2.02% of PhAR received, wherein the top portion of canopy exhibited a component with high and the bottom

TABLE 1 : Assimilation of photosynthetically active radiation (PhAR) by sole and intercropping systems with maize (M), sorghum (S), cowpea (C) and dolichos (D)

Time of cultivation (growth period)	PhAR received during growth period cal/cm^2/day	Crop(S)	Net above ground dry matter (DM) productivity g/m^2/day	Gross energy conserved cal/cm^2/day	Assimilation of PhAR (%)
July to August 1981 (48 days)	177.0	S	6.85	2.85	1.61
		C	2.27	0.76	0.43
		D	2.96	1.16	0.66
		S + C	8.87	3.58	2.02
		S + D	8.03	3.25	1.84
November 1981 to January 1982 (54 days)	227.0	M	7.76	2.93	1.29
		C	2.20	0.82	0.36
		D	5.43	1.64	0.72
		M + C	7.50	2.60	1.15
		M + D	8.66	3.21	1.41
February to April 1982 (56 days)	289.8	M	8.10	3.71	1.28
		C	4.66	1.80	0.62
		M + C	8.32	3.41	1.18

portion with low light requirement. The data shows that intercropping makes better use of light energy resulting in higher total productivity.

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Studies on ovicidal toxicity of few pesticides and a chitin synthesis inhibitor diflurobenzuron in the control of sorghum spider mite *Oligonychus indicus* Hirst (Acari : Tetranychidae)

The spider mite *Oligonychus indicus* Hirst is one of the important noninsect pests occurring on a wide variety of cereal crops and more so on sorghum and sugarcane causing substantial yield losses[3]. Some of the pesticides used to control this mite pest not only kill active stages but also eggs. The present study deals with the ovicidal action of certain commonly available pesticides which are used by the farmers and an insect chitin synthesis inhibitor against eggs and active stages of sorghum mite.

To find out the ovicidal toxicity of the pesticides, the gravid females from laboratory bred pure culture were allowed to lay eggs on sorghum (CSH-1) plants of 40 days old grown in pots. The leaves with one day old eggs were plucked from the plant and each of them was kept afresh in a petridish by placing wet cotton wad around the base of the petiole. The leaves bearing eggs were sprayed with the pesticides at recommended concentrations and diflurobenzuron at six different concentrations (Table 1) with the help of an atomizer to have a uniform coverage. Each treatment was replicated four times. Observations were made daily on the hatching of the eggs. The number of eggs hatched in each treatment were recorded upto one week after treatment and the per cent mortality was calculated. The effect of six concentrations of diflurobenzuron was also made on the duration of immature development of spider mite (Table 2). This study was conducted at a temperature ranging from 24.90 to 27.3°C and relative humidity 78 to 90.11 per cent. The individual mites were reared on insecticide treated excised leaves which were cut into bits of 2.5 cm^2, kept upside down on wet cotton contained in petridishes of 5 cm diameter. Four gravid females of *O. indicus* were confined on each leaf bit and were observed every 30 minutes for egg laying. As soon as one to two eggs were laid the time was noted and females were removed. Observations were made under stereobinocular microscope with 20x magnification twice (8 AM and 8 PM) daily, during immature development.

The mean per cent mortality of eggs varied from 11.89 per cent (0.01% diflurobenzuron) to 100 per cent (tetradifon and dicofol at 0.05%). The highest per cent egg mortality was preceded by the treatments endosulfan 0.07% (91.58 per cent) fenpropathrin 0.01% (86.37 per cent), diflurobenzuron 0.2% (86.0 per cent) malathion 0.1% (79.48 per cent) decamethrin 0.014% (77.41 per cent), cypermethrin 0.025% (69.96 per cent) and diflurobenzuron at 0.15% (37.52 per cent), 0.1% (33.70 per cent), 0.05% (27.27 per cent), 0.001% (12.89 per cent) and at 0.01% (11.07 per cent), untreated control (water spray) recorded the lowest mortality (1.48 per cent) which was on par with diflurobenzuron at 0.01% and 0.001%.

The efficacy of dicofol as an effective ovicide in the present studies is in conformity with the earlier reports[4], in which 84 per cent of eggs of *O. indicus* at 0.04% dicofol was obtained and complete kill of eggs of this species was recorded using dicofol at 0.03%[5]. Further 100 per cent mortality of

TABLE 1 : Ovicidal toxicity of few pesticides and a chitch synthesis inhibitor diflurobenzuron on *O. indicus*

Sl. No.	Chemical name	Trade name	Per cent EC/UP	Concentration (%) used	Per cent mortality of eggs
1	Tetradifon	Tedion	8 EC	0.05	100 j
2	Malathion	Cythion	50 EC	0.1	78.48 ghi
3	Dicofol	Kelthane	18.5 EC	0.05	100 j
4	Fenpropathrin	Meothrin	10 EC	0.01	86.37 ghij
5	Endosulfan	Thiodon	35 EC	0.07	91.58 hij
6	Ethion	Taphethion	50 EC	0.05	92.29 j
7	Decamethrin	Decis	2.8 EC	0.014	77.41 gh
8	Cypermethrin	Cymbush	25 EC	0.025	69.96 g
9	Diflurobenzuron	Demilin	25 WP	0.001	12.89 abc
10	Diflurobenzuron	Demilin	25 WP	0.01	11.07 ab
11	Diflurobenzuron	Demilin	25 WP	0.05	27.27 bcd
12	Diflurobenzuron	Demilin	25 WP	0,10	33.70 de
13	Diflurobenzuron	Demilin	25 WP	0.15	37.52 def
14	Diflurobenzuron	Demilin	25 WP	0.20	86.00 ghij
15	Untreated check (Water spray)				
	S. Em±				5.839
	C.D. at 5%				16.91

Treatments share similar letters are on par.

TABLE 2 : Effect of different concentrations of diflurobenzuron on developmental period of immatures of *O. indicus*

Sl. No.	Concentrations used (%)	Developmental period (days) of immatures			
		Egg	Larva	Protonymph	Deutonymph
1	0.001	2.31 ± 0.36	1.94 ± 0.42	1.62 ± 0.15	2.41 ± 0.42
2	0.01	2.27 ± 0.17	1.94 ± 0.35	2.06 ± 0.18	1.86 ± 0.18
3	0.05	2.37 ± 0.20	1.98 ± 0.30	2.99 ± 0.44	3.05 ± 0.17
4	0.10	2.58 ± 0.30	2.03 ± 0.24	3.52 ± 0.44	3.48 ± 0.74
5	0.15	2.60 ± 0.30	3.54 ± 0.72	**	**
6	0.20	3.98 ± 0.30	*	*	*
7	Untreated check	2.14 ± 0.12	1.38 ± 0.33	1.82 ± 0.31	2.43 ± 0.24

* = Indicate immatures died after egg hatch.
** = Indicate immatures died after completion of larval period.
Note : Each observation is the mean of 12 individuals

eggs was reported[1] with the use of tetradifon at 0.025%, 0.05% and 0.075% and dicofol at 0.05% and 0.075% which confirm the present findings. However no egg mortality of this species have been obtained[1] by using malathion 0.025%, 0.05% and 0.075%, this may be due to the lower concentrations and or the change of host used in those studies. The detailed studies on the ovicidal effect of chemicals endosulfan, ethion, fenpropathrin, decamethrin, cypermethrin and diflurobenzuron are not made earlier and therefore form a new findings with respect to this species.

Of the six different concentrations of diflurobenzuron tested (Table 2), all have showed a considerable influence on the duration of immature stages, the lower concentrations effected a lower developmental periods while the higher concentrations prolonged those periods. The different immature developmental periods ranged from 2.31 ± 0.36 days (0.001%) to 3.98 ± 0.30 days (0.2%) for eggs, 1.94 ± 0.42 days (0.001%) to 3.54 ± 0.72 days (0.15%) for larvae, 1.62 ± 0.15 days (0.001%) to 3.52 ± 0.44 days (0.1%) for protonymph and 2.41 ± 0.42 (0.001%) to

3.48 ± 0.74 days (0.1%) for deutonymphs. However the concentrations of diflurobenzuron at 0.15% and 0.2% were prevented larvae and eggs to develop further respectively (Table 2). The immatures in untreated check took on average of 2.14 ± 0.12 days, 1.38±0.33 days, 1.82±0.31 days and 2.43±0.24 days respectively for egg, larvae, protonymph and deutonymph stages. The results indicated that diflurobenzuron at 0.2% was most effective on eggs and immature active stages of *O. indicus*. However the lower concentrations in the study with less residual effects on the eggs and active immature stages are partly in support of findings[2] in which recorded diflurobenzuron to be least toxic to adults and nymphal stages of *Tetranychus cinnaborinus* (Boisd.).

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Drugs suppress brown-spot infection in rice

Besides the conventional plant protection chemicals, many others have also been tested on a variety of crops against different diseases, and success has been occasionally reported[1-3]. Among the effective chemicals are metal salts, amino acids, plant growth regulators, and diverse other compounds. Wain and Carter[4] have reported several cases of effective disease control with drugs like sulphonamides, barbiturates, and penicillin. Extensive studies in this laboratory have shown that pre-sowing wet seed treatment with a host of chemicals, all known to induce the production of phytoalexin type resistance factor in plants[4], provides effective protection to rice plants against brown spot[5-8] and blast[9], two of its major diseases. Known phytoalexin inducers also include some drugs against various ailments[10]. We report here the effect of two such drugs on brown spot of rice incited by *Helminthosporium oryzae* Breda de Haan. These are primaquine, an anti-malarial drug, and propantheline bromide, an anti-cholinergic drug.

Grains of a highly susceptible rice cultivar "Dharial" were soaked for 24 hr in dilute chemical solution (10^{-3}, 10^{-4}, and 10^{-5}M) or distilled water (control) before their sowing in soil in 16 cm pots. Plants were spray inoculated with a spore suspension (c. 5 x 10^5 conidial/ml) of the pathogen, when 3 wk old. Symptoms were assessed 4 days later and disease index computed taking into consideration both the number and relative size of the lesions from thirty plants[11]. Propantheline bromide caused considerable reduction in symptoms at 10^{-3}M, but had little effect at 10^{-4}M and only mild effect at 10^{-5}M (Table 1). Primaquine had less effect. Only moderate reduction in symptoms was achieved with 10^{-4}M but with immediate higher and lower concentrations, moderate increases were noted. In bioassay against spore germination of *H. oryzae*, propantheline bromide almost

TABLE 1 : Effect of seed treatment with two chemicals on brown sopt infection of rice seedlings

Treament	Conc. (M)	Mean disease index / plant*
Water (control)		12.1
Propantheline	10^{-3}	6.0 (–50.4)
bromide	10^{-4}	11.6 (–4.1)
	10^{-5}	10.0 (–17.6)
Primaquine	10^{-3}	14.7 (+21.5)
	10^{-4}	8.8 (–27.3)
	10^{-5}	15.1 (+24.8)
C.D. (P = 0.05)		2.91
C.D. (P = 0.01)		4.06

* Results based on 30 plants, 10 each from 3 pots per treatment; Value in parentheses indicates percentage increase or reduction in terms of control,

totally inhibited spore germination at 10^{-3} and 10^{-4}M and had a strong effect even at 10^{-5}M, but primaquine showed strong inhibitory effect at 10^{-3}M only and much milder effects at the lower concentrations.

Propantheline bromide, more effective of the two, was further tested for different duration of pre-sowing treatment (24 and 48 hr) alongwith thioglycollic acid, a reducing agent reported earlier to be a strong inducer of resistance[6], used for comparison. Rice seedlings were inoculated at two stages, after 2 and 4 wk. Though both compounds provided rice plants significant levels of protection between 2 and 4 wk, propantheline bromide was not as effective as thioglycollic acid (Table 2). Nevertheless, these elicited almost similar host responses. With both, the induced resistance took time to develop and mostly became stronger at 4-wk stage. Increase in the duration of treatment from 24 to 48 hr did not result in any better protection; rather with propantheline bromide, there was a decline in effect after 4 wk.

TABLE 2 : Effect of duration of seed treatment with two chemicals on brown spot symptoms in rice, when inoculated after 2 and 4 wk.

Treatment	Duration	Mean disease index / plant	
		2 wk	4 wk
Water (Control)	24 hr	12.6	25.5
Propantheline bromide (10^{-3}M)	24 hr	6.6(–47.6)	10.4(–59.2)
	48 hr	6.8(–46.0)	14.1(–44.7)
Thioglyeollic acid (10^{-4}M)	24 hr	4.8(–61.9)	7.1(–72.2)
	48 hr	4.7(–62.7)	7.7(–69.8)
C.D. (P = 0.05)		1.6	2.3
C.D. (P = 0.01)		2.4	3.3

Values in parenthesis indicate percentage reductions in terms of control

It appears that like other phytoalexin inducers, those with medicinal properties may also be active on plants against their pathogens, the magnitude of effect varying with the compound. There is neither any concentration effect nor longer treatment led to any greater effect. Further, the induced resistance takes time to be optimally active and becomes stronger in older seedlings, at least up to the stage observations were made. All these would suggest that propantheline bromide controls brown spot infection in rice plants not through any direct action on the pathogen but possibly through some induced changes in host metabolism that does not favour its continued activity *in-vivo*. The scope of using such drugs in plant disease control merits exploration.

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Further studies on the control of loose smut of wheat by water soaking of seeds

Tyner[1] was the first to report complete control of seed-brone loose smut infection of wheat incited by *Ustilago tritici* (Pers.) Rostr. by pre-sowing soaking of grains in water for 48 hr. Some later studies reported complete control by such treatment for longer[2] or even much shorter[3] period. There is much variation in these reports about the period of soaking needed for complete control. Most of these studies had been done with seed samples having low incidence of infection. So, the availability of a wheat seed sample with high percentage of infection prompted us to reinvestigate the effect of seed soaking on loose smut disease of wheat.

Wheat grains (cv. Sharbati sonora) were soaked in distilled water (pH 7.0) or tubewell water (pH 7.6) for 12, 24 and 48 hr and also for 24 hr in distilled water brought to lower (5.6) or higher (7.6) pH and then sown, twenty-five in each of two 28 cm pots per treatment. In the control treatment using dry (untreated) grains for sowing, 63% plants developed smutted head. Soaking even for 12 hr had an appreciable inhibitory effect, causing 28% reduction in disease incidence irrespective of the source of water used. Following 24 hr treatment, much increased reductions were recorded, as high as 75% with dist. water at pH 5.6 and 7.0, slightly less with same water at pH 7.6 and further less though still significant (50%) with tubewell water (pH 7.6). Complete control was achieved with 48 hr treatment, irrespective of water source. While picro-aniline blue stained longitudinal sections from ten infected plants in the control treatment showed hyphae all along the stem up to the base of the smutted head in every case, none from the same number of plants in both 48 hr treatments showed any fungal presence in the stem suggesting the development of a fungitoxic condition in these plants. There had been reports earlier also about the presence of fungitoxic factor in wheat germ extract obtained after soaking[4,5]. So, further studies were undertaken in this respect. Wheat grains were soaked in dist. water (4 g in 10 ml) for different periods from 2 hr (just to make them soft and extractable) to 48 hr. Afterwards, each lot of soaked grains were thoroughly washed in water and then extracted in a mortal and pestle with 10 ml of dist. water. After clarification through centrifugation at 8000 g for 10 min, these were assayed for fungitoxicity against *Helminthosporium sativum* Pammel, King & Bakke, a wheat pathogen, by slide germination technique[6]. As compared to the extract from grains soaked for 2 hr that from grains soaked for 12 hr only mildly inhibited conidial germination but suppressed germ tube growth substantially (Table 1). With 24 hr soaking, inhibitory effects further increased, and after 48 hr, very strong effects were recorded?

TABLE 1 : Effects of extracts from water soaked wheat grains (cv. Sharbati sonora) on spore germination of *H. Sativum*

Extract from grains soaked for (hr)	Spore germination (%)*	Mean germ tube growth (μm)+
2	70.0	112
12	60.8 (13.1)	25 (77.7)**
24	44.2 (36.9)	11 (90.2)**
48	22.7 (67.6)	4 (96.4)**

* Average of 400-420 spores
+ Average of 90 gemlings
** Treatment effect significant at 1% level

Data in parentheses indicate percentage reductions in terms of that recorded with extract obtained after 2 hr soaking.

Though bioassay was done not with *U. tritici* but with another wheat pathogen, still the greater inhibitory effect of various extracts on germ tube growth than on spore germination is of significance as in the case of loose smut, the success of infection depends on early activation of the 'dormant' mycelium within the embryo and its rapid growth into the emerging shoot. Even after 12/24 hr soaking, enough fungitoxicity may develop in many of the infected grains to suppress further growth of the activated mycelium so that it fails to reach the stem in time. After 48 hr, this happens in every grain thus providing complete control of loose smut.

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Biosynthesis and qualitative analysis of cardenolides in *Calotropis gigantea*

Calotropis gigantea (Linn.) R. Br. ex Ait is an important medicinal plant with many therapeutic values[1-3]. It acts like *Digitalis* particularly for heart diseases[1] due to the presence of cardiac glycosides (cardenolides), the chief secondary metabolites of the plant[3,4]. Still very little systematic efforts have been made both *in situ*[5,6] and *in vitro*[7,8] by earlier investigators to explore and exploit this valuable drug, enriched with cardenolides. Therefore, the study was focussed on the biosynthesis and qualitative analysis of cardenolides. In this connection, cardiac glycosides (cardenolides) have been quantitatively measured from the roots (as roots contained maximum amount of active principles). An attempt was also made to elucidate the role of micro- and macro-elements in biosynthesis of this active principle. Qualitative study revealed the presence of two cardenolides, Calotropin and Uscharidin which were confirmed by co– TLC and HPLC analysis both *in situ* and *in vitro*. This communication also reports that cardenolide biosynthesis is related with and effected by the relative quantity of micro- and macro-elements.

TABLE 1 : Distribution of Cardiac glycosides (per cent of dry wt) in different population of *C. gigantea*

Variety	P–I	P–II	P–III
Red	0.88 ± 12	0.60 ± 24	0.81 ± 24
White	1.22 ± 20	1.42 ± 20	0.96 ± 10

Roots were collected from one-year old crop of both the varieties (red and white[1]) of *C. gigantea*. Three different populations, P–I, P–II and P–III (Table1) of BCCL, Durgapur; IISCO, Burnpur and RLT, Bolpur respectively were considered for the study of active principles. Quantitative and qualitative studies of cardenolides were carried out by taking 1 kg material from each population. Qualitative study in tissue culture was done from the calli produced on MS (Murashige and Skoog) medium. Other tissue culture aspects have been reported earlier[7-10]. Both friable calli, produced by 2, 4-D (2, 4-dichlorophenoxyacetic acid, 2 mg l^{-1}) and IAA (indole-acetic acid, 2 mg l^{-1}) treated hard calli of 120 days were undertaken and cardenolide contents were determined following the method of Brower *et al.* [11], where Digitoxin was used as standard[12]. For qualitative study of cardenolides, modified method of Sieber *et al.*[13] was considered followed by TLC and HPLC analysis. Compounds extracted in different solvents[11,13] were separated out by TLC and identified by co–TLC[14] and HPLC analysis which was done on a column C_8-Reverse phase of UV- Spectra Physics Model SP 8440 with the operating conditions as follows : eluting solvent, methanol; flow rate, 1.5 ml/min; wave length of UV-detector, 226 nm.

TABLE 2 : Relative amounts of some macro– and micro-elements, pH and conductivity in soil samples of various populations

Variety	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	Carbon (organic)			pH value	Conductivity (TSS)* millhos/cm
Red	20.80	15.20	4.20	9.96	1.43 (VH)*	16.6 (L)*	75.2 (VL)*	7.2 (N)*	1.10
P–I White	27.20	14.00	7.20	7.30	1.40 (VH)	13.4 (L)	129.2 (L)	7.7 (N)	0.30 (N)
Red	9.60	3.60	16.60	7.30	1.13 (VH)	20.5 (M)*	385.0 (VH)	7.1 (N)	0.22 (N)
P–II White	33.60	12.40	6.80	24.56	1.40 (VH)	12.2 (L)	273.0 (H)*	7.9 (N)	0.22 (N)
Red	27.20	30.80	10.60	16.60	1.29 (VH)	18.6 (L)	371.0 (VH)	6.7 (N)	0.29 (N)
P–III White	9.20	4.00	25.00	19.25	1.40 (VH)	9.9 (VL)	258.0 (H)	7.0 (N)	0.29 (N)

* TSS = Total soluble salts; VL = very low; L = Low; N = Normal; H = High; VH = Very high; M = Moderate

Table 1 shows the correlative studies on cardiac glycoside content of the two varieties of *C. gigantea*. They reveal that the industrial pollutants of P–II have greater effects on reduction of cardenolide content in red variety and not in P–I with the healthy pollution-free population (P-III). However, the white variety of P–II did not show any reduction in its content and lower amount was achieved in P–III. At the same time, the white variety contained more cardiac glycoside than the red variety.

Soil analysis of P–II (red variety) and P–III (white variety) revealed the presence of lower amount of Fe and Mn and higher amount of Zn (Table 2). Significant changes were noted in the white variety of P–II. Organic carbon was found to be very high in all cases and N–contents were normal. Phosphorus contents were lower in all populations of the red variety except in P-II and similar conditions were observed in three populations of white variety. Potassium content was found very high in P-II and P-III of red variety. Lower amount was noted in P–I of both the varieties. pH and conductivity (TSS) were normal in each case. Thus, Fe, P and K play significant role in the biosynthesis of cardenolides. Qualitative study on callus tissues and *in vitro* raised roots revealed the presence of a number of cardenolides. The amount of cardenolides enhanced with the age of the culture[7, 9]. Two cardenolides—Calotropin and Uscharidin—were confirmed by co-TLC and HPLC analysis like *in situ* condition.

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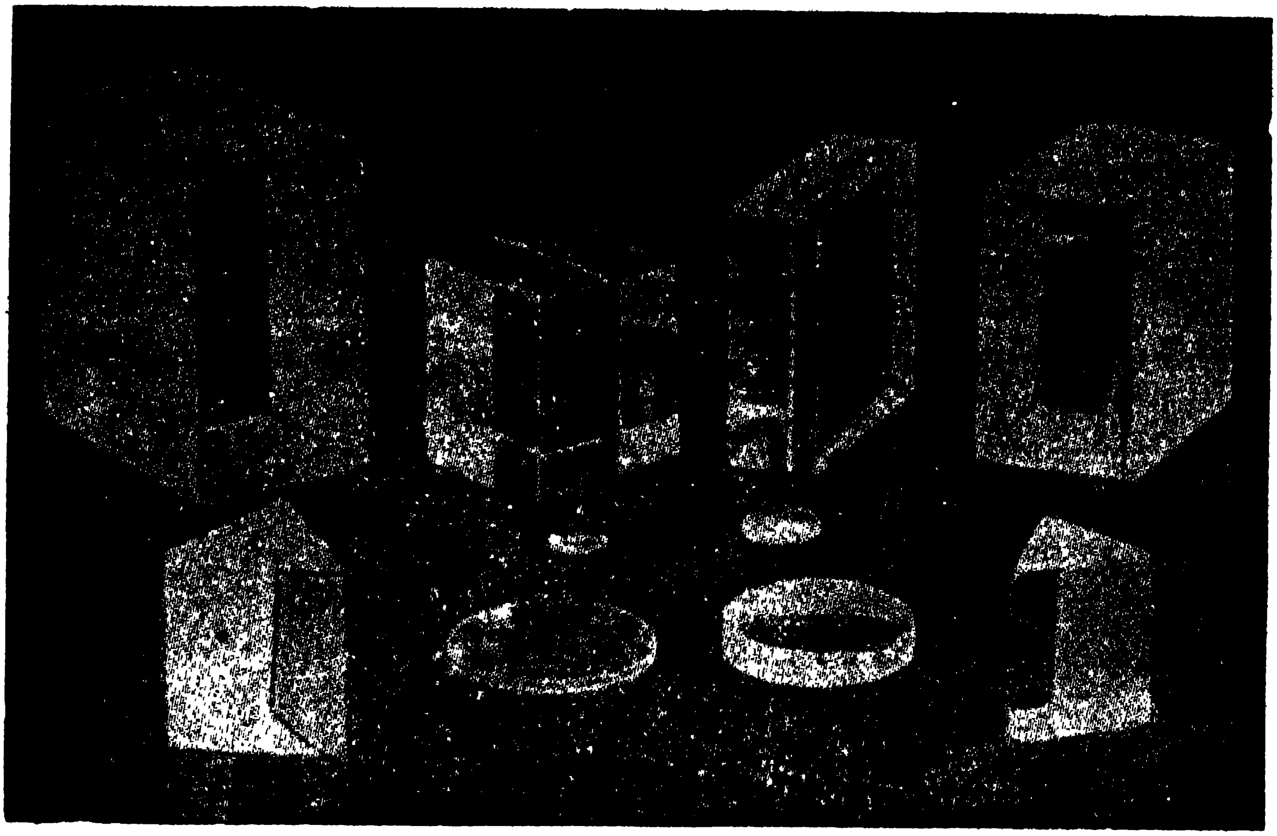

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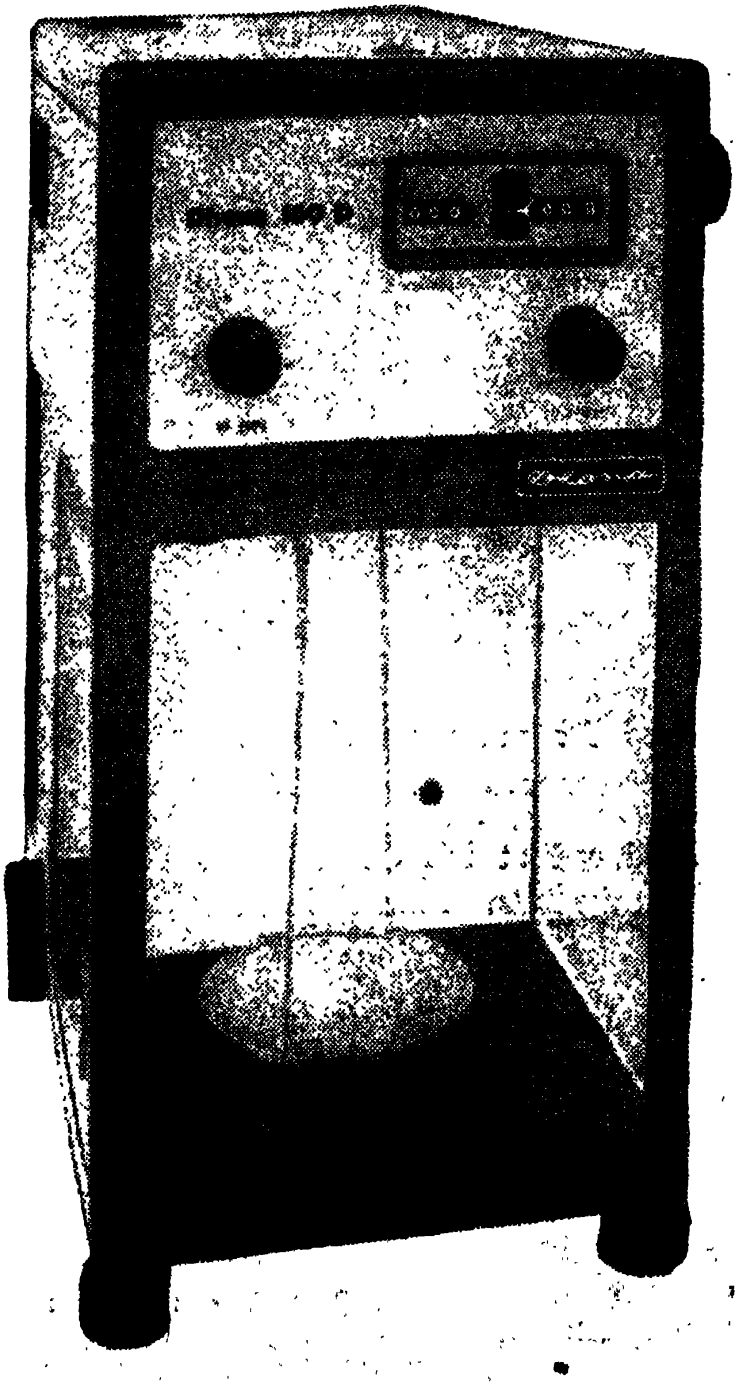

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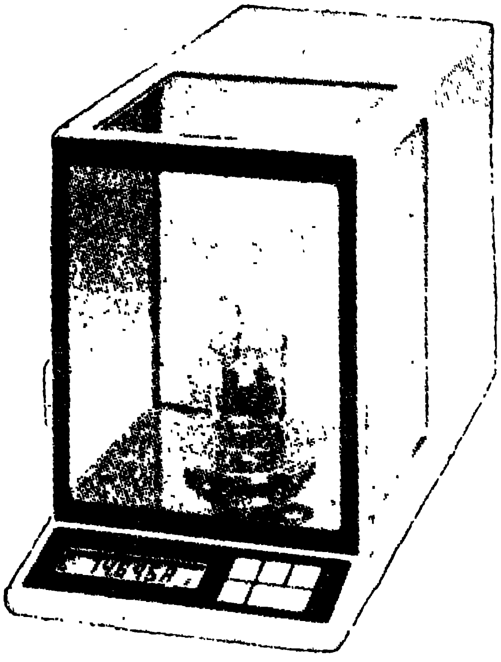

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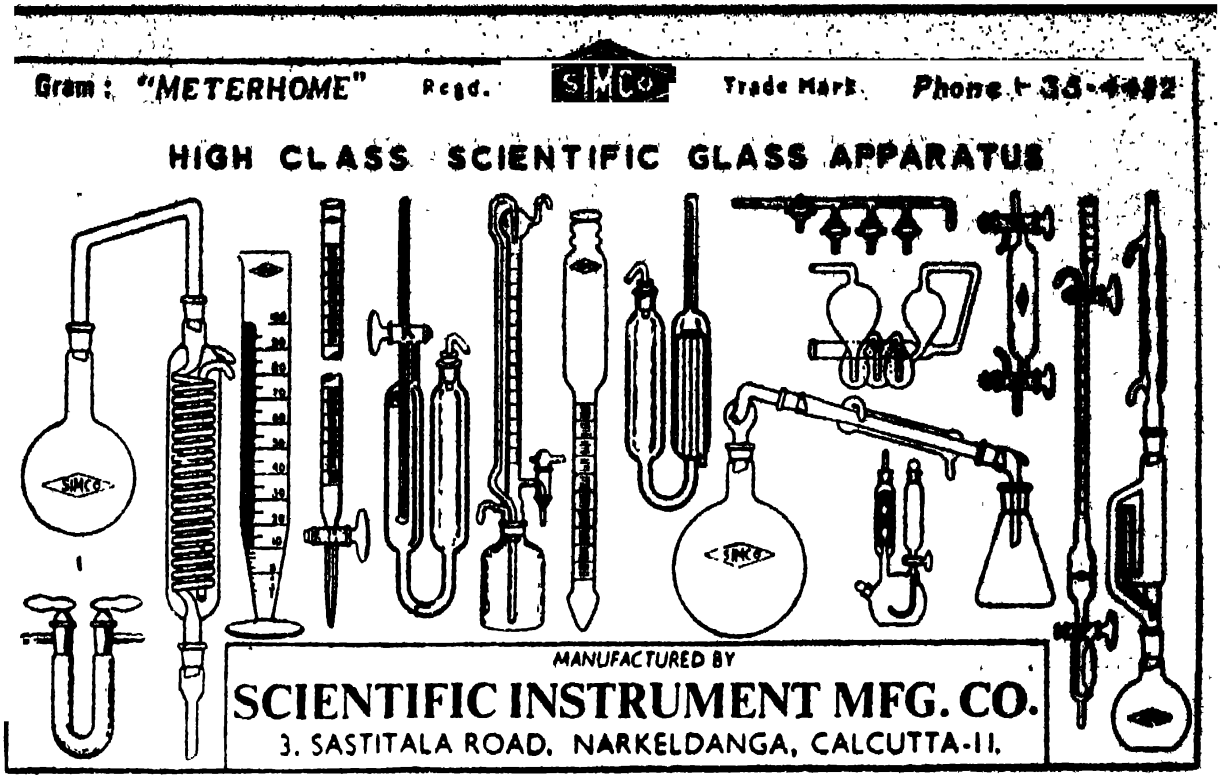
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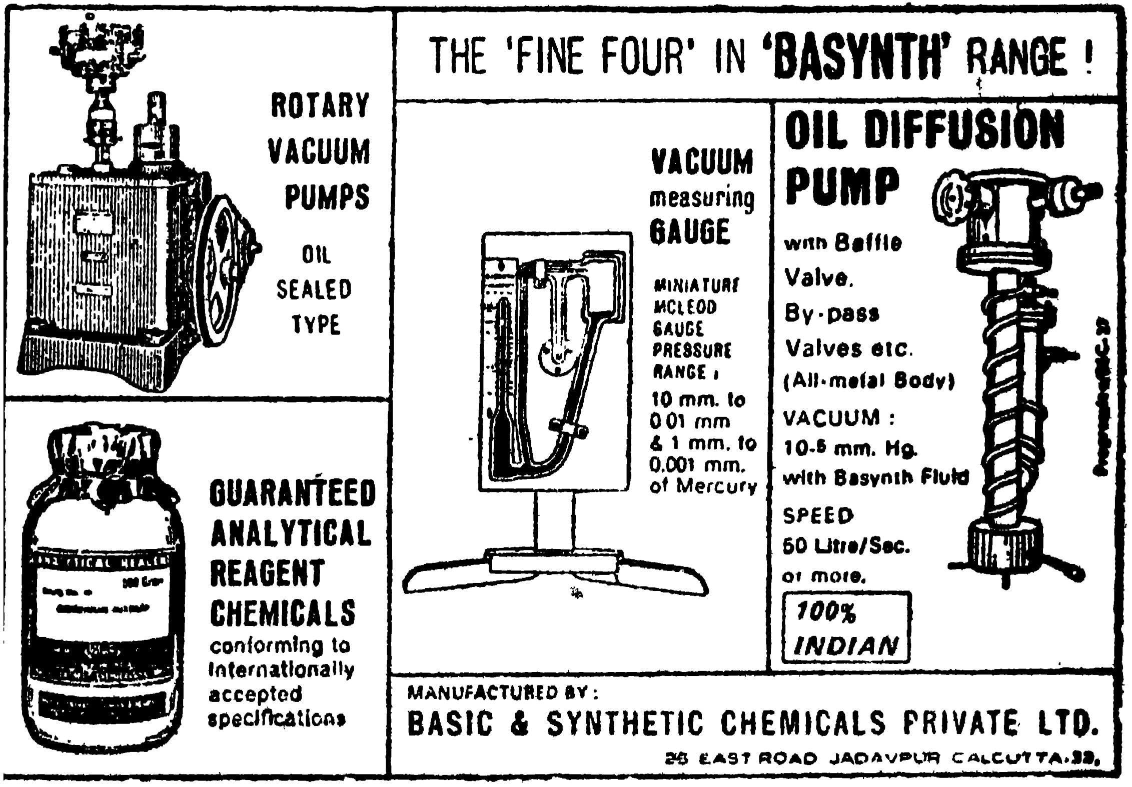
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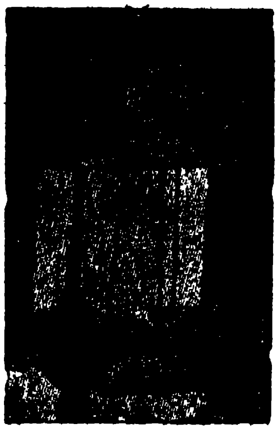

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SCIENTIFIC ATTITUDE

THE Indian Science News Association established (1935) more than fifty three years back has for its main aim the dissemination of science. Its founding fathers had realised clearly that without a sound scientific and technological basis a nation could not progress and the developmental programmes to alienate the woes of the people cannot succeed. One may recall in this context the opinion held by Adam Smith of the United States of America almost two centuries ago : *the wealth of a nation depends in part on the skills and knowledge of its people.* In the thirties when the world was on the threshold of great scientific discarries and rapid technological revolution the understanding of new scientific ideas and developing technological skills was bound to follow as determining factors for bringing prosperity to a nation. At that time the Indian populace was in a State of flux. The idea to break the shackles of colonial rule and gain total independence had caught the imagination of the general masses. The intellectuals, who were watching the progress made by other independent countries, were convinced about purposeful scientific planning. Pandit Jawaharlal Nehru who was very much impressed by the rapid developments brought about by the five year plans in Russia had initiated a group in the Indian National Congress to discuss scientific planning for the country in the late thirties itself. And the platform of Indian Science News Association was used to ventillate some of the nebulens ideas of great thinkers of that time. It may not be an exaggeration if it is said that the pages of *Science & Culture* had the genesis of Indian's National (Five year) plans. Having traversed a distance of more than fifty years in time, [illegible]

to take up new projects in [illegible] of knowledge in science & technology.

It is commonly accepted today that science is a mystery to great numbers—that it appears to be largely inaccessible even to men and women who believe themselves educated—and this condition is scarcely improving. This is not only true about the under-developed countries but the alarm is noticed in many developed ones too. Even the United States laments at its decreasing scientific literacy. It has been observed by many economists in a number of studies which reveal that throughout the world—including the less industrialised countries—the abilities of the people, together with the advances in knowledge, have raised their economic standing and with it, other aspects of life that contribute to their overall sense of wellbeing. According to Theodore W Schultz, a Nobel prize winner in economics, *science is a special form of 'human made' capital ; it is embodied in scientific literature, in economically productive developments such as computers and hybrid corn, and in human beings. To broaden knowledge of it requires the investment of scarce resources—mainly the time and effort of people— to gain future returns and satisfaction. The improved literacy—scientific technological and other kinds—that is the result of such sacrifices has been far more important to the industrialization of the West that is generally acknowledged. And it will continue to be as vital to the well being of post industrial or information societies as it is for low income countries seeking to modernize.*

The acquisition of scientific literacy and the enlargement of general knowledge on the part of the individual had only been intuitively understood and was best observed in extreme cases. However, distinguished scientific accomplishments is a matter of opportunity and of continuous and constant effort over long periods of time. When Newton was asked how he had managed to surpass the discoveries of [illegible] predecessors, in both quantity and quality, he replied, "by always thinking about them". The comment of Gauss to such a question was "if others would but reflect on mathematical truths as deeply and continuously as I have, they would make my discoveries" and it is apparent that the idea of 'instant' scientific discoveries is a myth.

This is true also regarding accomplishments in many other areas. Psychological studies of the lives of eminent painters, writers, musicians, philosophers, religious leaders, and scientists of previous centuries as well as prize winning adolescents, reveal early, intense concentration on previous work in their fields, often to the near exclusion of other activities. Science and mathematics, because of their highly specialised and abstract symbolism, may require the greatest concentration and perseverence. The same fundamental thought processes, moreover, appear to be required in both elementary and advanced science. The development of literacy, acquisition of information, and the problem solving of beginners differ in degree rather than in kind from the mental activities of experts. The scarce resources are opportunity and concentration rather than the amount of information available or the processing capacity of the mind, both of which, for practical purposes, are unlimited.

The prospect of prodigious and sustained concentration should impress the novice, especially in science and mathematics. Yet a small fraction of the total is required for literacy, only an extra hour or two per day, taken, perhaps, from usual several hours of other activities for both adults as well as children. Children of normal intelligence possess the requisite mental mechanisms and processes for respectable attainments; they can acquire scientific literacy and master the information and skills.

A good example to cite is that of Japan with its uprecedented post-war economic growth. Japan was relatively poor, compared to many western countries, in the early part of this century, with practically no physical resources. It showed to the world that heredity cannot determine large changes over short time periods, the changes are most certainly attributable to social environment, family circumstances, education, health, and other human capital investments and enhancements. Since Japan lacked valuable minerals, arable land, and until recently, financial resources, its uprecedented success must in large part attributable to investments in human knowledge and skills and improved western technology.

Soon after independence, India embarked on scientific planning of its economy and put stress on technological developments. Thanks to the farsightedness of its first prime minister Pandit Jawaharlal Nehru, who could persuade his cabinet colleagues and take them along. This year, the birth centenary year of Pandit Nehru, the nation could appreciate far better the course taken by him amidst the shattered economy of the post colonial days. His stress on research in science and technology have started bearing fruits. The steady growth of economy is the result of the right path taken by the successive governments following the cue given by the first prime minister. The cadre in the fundamental research in all branches of science has steadily increased and has got quite creditable reputation in the world scientific community. The applied sciences and technology have taken great strides but because of the large (and increasing) population the effects are felt marginally. To make this progress more meaningful what is required is the right scientific attitude, which cannot be brought about over a short period but has to be cultivated or developed. The government can wish and stress the need of it and take satisfaction in the pertial success of its plans, blaming the short comings on this aspect. Scientific attitude amidst people has to be inculcated by voluntary organisations, mass media and educational institutions, the last one especially in younger generation.

What is required is the removal of superstitious beliefs, either brought about by obscure religious rituals or social customs. A deep belief in fate is the other characteristic of Indian population. This attitude has got a great retarding effect on any thing a man wants to do and can do. Science and modern technology have changed the fates of many a nation. A good example are the countries around Japan in Asia, where, to put in a few words, the people have taken destiny in their own hands. It can be achieved by conveying to the masses the beauty of science as revealed to the scientists and the benefits of technologies following it as envisioned by technologists.

However, dissemination of science or science and technology communication is not an easy task. Great care has to be taken not to convey wrong interpretation which may mislead the truth about original ideas. There is a great moral and ethical responsibility on the science popularisers on this account.

The Indian Science News Association has taken upon itself, the task of training young graduates for science and technology communication in various media practices. These courses given in the evening for five to eight weeks to students who have achieved certain amount of communication skills and have a flair for science & technology, are gaining in popularity. However, compared to the task outlined above, the achievement of the Association is very small. But there is satisfaction that the impact of the work is in the right direction.

The government of India through Department of Science & Technology (DST) has initiated a more to introduce rigourous and conventional courses in the universities on science and technology communication. India with its multi-language constitution has different regional approaches to achieve the goal and hence the DST organised regional workshops to prepare suitable syllabus for one year diploma course in science and technology communication.

The eastern regional workshop held during October 4-6, 1988 with various academic personnel from the universities, journalists and media practitioners was useful exercise. Organised by the Indian Science News Association, it is expected that the final report will be brought out before the end of the year in the pages of *Science & Culture* itself. The approach paper to deliberate upon and to produce the final report is given in boxed form. It gives the likely items that will be included in the syllabus. We earnestly hope that our humble attempts will be rewarded by the adoption of the syllabus by some university in the region. ☐

B. B. Baliga

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VOLCANIC ERUPTIONS AND CLIMATE

P. K.DAS*

The article reviews the impact of volcanic eruptions on the earth's climate. The main features of major eruptions are summarised, and the optical features of magma are discussed. These properties are discussed in the context of the radiation balance of the earth and its atmosphere. A comparison of the greenhouse effect due to aerosols between the earth and Venus is made. Finally, we discuss the implications of volcanic eruptions on the earth's climate.

Introduction

Small particles of dust, or aerosols, can change the intensity of solar radiation by absorption or scattering. In this context, it is relevant to consider the impact of volcanic eruptions because they release large numbers of aerosols with explosive violence. The subsequent spread of the aerosol population, as a function of space and time, it capable in influencing the earth's climate. Our concern over climatic changes is exacerbated by the possibility of a nuclear winter. But, although nuclear winters are an outcome of human folly and are not natural catastrophes, there are similarities between the repercussions of a nuclear explosion and a volcanic eruption.

Lack of information on the optical properties of aerosols and their distribution in space makes it difficult to quantify their impact on the earth's radiation balance. But, one aspect is fairly clear : a thick layer of dust or ash particles will cutt off a substantial fraction of incoming *sunlight.*

Kondratyev[2] refers to a publication by Benjamin Franklin in 1784 wherein it was suggested that the abnormally low temperatures of the previous year's summer of 1783, and the severe winter that followed, were caused by the heavy load of volcanic smoke in the atmosphere. This was smoke released by eruptions from a crater (Laki) in Iceland. The eruptions began in June of 1783 and lasted eight months.

Major eruptions

The debris from a volcanic eruption is magma. This is a pasty mixture of molten rock and lava from the earth's interior. Spectacular sunrises and sunsets with red or orange skies are seen over many parts of the globe following an eruption. They are effects of scattering by micron sized aerosols. A micron is a millionth of a metre.

The main feature of prominent eruptions of the past are summarised in table 1.

TABLE 1 : Prominent Volcanic Eruptions[3]

Volcano	Country	Year	Magma (km^3)	H (km)	H_2SO_4 (million tons)	Temp. change (°C) over N. H.
1	2	3	4	5	6	7
Laki	Iceland	1983	13	Low	100	–1.0
Tambora	Sombawa Indonesia	1815	50	45	150-200	–0.4 to –0.7
Krakatau	Pakata Is. Indonesia	1883	10	40	50-55	–0.4
St. Maria	Caribbean Is.	1902	9	30	20	–0.04
Katmai	Alaska	1912	15	27	20	–0.2
Mt. Agung	Bali, Indonesia	1963	0.4 to 0.6	18	10-20	–0.3
St. Helins	Washington	1980	0.35	22	3	0 to –0.1
Elchichon	Mexico	1982	0.35	26	10-20	–0.4

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The entries in the fifth column refer to the altitude reached by the debris in kilometres. The last column provides values of the average cooling observed at the ground over the northern hemisphere. Note that all major eruptions lead to cooling near the ground.

An indication of the explosive force of an eruption is provided by the Tambora eruption of 1815. It was estimated that the debris were lifted upto 45 km, despite the higher stability of the stratosphere.

The bulk of the debris from these eruptions are able to travel round the globe in three to four weeks. Volcanic clouds generally extend from the tropical tropopause (16 km) to an altitude of 30 km. The peak concentration is around 25 km. The debris consist of ash, compounds of sulphur, chlorine and silicates.

The longer particles of ash tend to be removed by sedimentation of falling rain within a few days. On many occasions, the sulphur dioxide combines with water vapour to form minute drops of sulphuric acid. These drops, which have diameters of the order of a micron, are efficient scatterers of solar radiation.

A side effect of volcanic debris is interference with sensitive radiation measuring equipment on satellites. This happened in 1985. Ground based measurements of ozone could be also influenced by chlorine.

Optical features

Most of the radiation from the sun arrives on the earth in the form of short-wave (visible) radiation. This is in the wavelength range of 0.2 to 4.0 microns. Some of it is reflected back to space by air molecules, clouds and the earth's surface. But, about 51% of the incoming solar radiation is absorbed.[1] It heats the earth.

The warm earth emits long-wave infrared radiation. This is in the range of 4.0 to 80 microns. A part of the long wave radiation is absorbed by the atmosphere. The retention of infrared radiation in the atmosphere is referred to as the "greenhouse effect". Aerosols contribute to the greenhouse effect, but its contribution is small in comparison with other greenhouse gases, such as, carbon dioxide, ozone, methane or the oxides of nitrogen.

The principal role of aerosols is to alter the intensity of solar radiation (short wave) by scattering and absorption. This is measured by (i) an extinction coefficient (K_e) and (ii) and absorption coefficient (K_a). Both coefficients are expressed in units of m^2/g, where g is the mass of an aerosol particle. The difference between (i) and (ii), namely (K_e - k_a) is the scattering coefficient, while the ratio (K_e - k_a)/K_e is the single scattering albedo of a particle. It measures the reflective power of a single particle. If we multiply K_e by the amount of particulate matter for every square metre along the path of radiation (in units of g/m^2) then we have a dimensionless variable which is known as the 'optical depth'. Thus, if δa be the distance traversed by the radiation through an aerosol layer, the optical depth of the layer will be $K_e\ \delta a$.

Another important feature is the refractive index of an aerosol. This is a complex variable with a real and an imaginary part. The complex part of the refractive index measures the decay in the amplitude of the incident radiation on striking a particle for unit distance. It is thus the absorption coefficient (K_a) of a particle.

The impact of solar radiation on a dust particle creates a disturbance. The amplitude of the radiation is thereby diminished and a spherical wave is generated at distances that are large compared to the wavelength of the incident radiation and the size of the particle. The energy carried away by this wave is the scattered energy, and the energy lost by the incident wave is measured by the extinction coefficient. Fuller details of the scattering process will be found in a publication by Van de Hulst[3].

The optical depth of the aerosol layer associated with the El Chichon eruption of 1982 was estimated to be around 0.12. This was sufficient to decrease the intensity of incoming sunlight by 18%. But, by way of contrast, the reduction of sunlight by a hypothetical nuclear explosion will be much more. The transmission through an aerosol or smoke filled medium is given in table 2 for a solar zenith angle of 60°.

TABLE 2 : Optical depth and transmission of sunlight[1]

Optical depth (1)	Transmission (2)	Main features (3)
1.0	0.35	Cloudy
2.1	0.10	Very cloudy
4.0	0.01	Limit of photosynthesis
15.0	10^{-4}	Moonlight

Opinions differ, but it has been estimated that a nuclear explosion of medium size could generate 2 × 10^{14} grams of soot and smoke. This is the equivalent of 2 billion metric tons and an optical depth of 4.0. The extinction of sunlight will be much more than the 18 per cent decrease caused by magma from the Elchichon eruption of 1982. There are uncertainties in these figures; one does not know, for example, how far or how high the smoke will travel. But, the possible repercussions are clear.

Comparison with planetary dust

Venus and Mercury are the only two planets closer to the sun than Earth. Some information about their atmosphere has been gathered by sapce probes.

The thick and cloudy atmosphere of Venus exerts a pressure on its surface which is almost a hundred times greater than the Earth's atmosphere. Astronomers find that despite the slower rotation of Venus round the sun, and on its own axis, its atmosphere has clouds that travel around the planet every four Earth days. They indicate very strong winds in the upper atmosphere. Around 1982, the Soviet space ships Veneras 13 and 14 landed on Venus and one of them stayed for over two hours. It reported a bright orange sky and rocks of reddish brown colour, similar to what is observed after an eruption.

Despite the fact that the atmosphere of both Venus and Mars is largely Carbon dioxide, and the Earth's atmosphere is mostly Nitrogen and Oxygen, a considerable amount of micron-sized sulphur particles has been found in the atmospheres of Venus and Earth. On Earth the aerosol layer is concentrated around 18-20 km with a density of 1-2 cm^{-3} for particles with diameters of a fraction of a micron. The global cloud cover on Venus is located at a higher altitude of 45-75 km. Their number density is about a hundred times greater than that found in the Earth's atmosphere. Under the main cloud cover of Venus, a thinner layer of haze has been observed at altitudes between 30 and 45 km.

The origin of sulphate granules in the atmospheres of these three planets—the Earth, Venus and Mars—is believed to be due to volcanic activity. There is evidence of persistent volcanic eruptions on Mars, but the evidence is not so firm on Venus. Differences exist on the time required to form sulphates in the atmospheres of Venus and Mars. These differences arise because of lack of oxygen in these two planets. Oxidation of sulphur is a comparatively slower process in both Mars and Venus.

Numerical models of the Martian atmosphere has been attempted. The information that is available on winds suggests considerable subsiding motion during most parts of the year. This is believed to be the cause of sedimentation of sulphate-particles to the ground. Fairly high concentrations of sulphates were observed near the landing sites of the Viking space craft on Mars.

Climatic impacts

We have so far considered only scattering and the extinction of sunlight by a dense aerosol layer. But, there are other possiblities to be considered.

The impact of volcanic eruptions on climate occurs through an increase in stratospheric dust, especially in the post-eruption period. This leads to warming of the stratosphere and a slight cooling of the lower troposphere.

Few attempts have been made to relate the mean temperature of the atmosphere to volcanic eruptions, but the evidence is not firm. Thus, the absence of volcanic eruptions for almost three decades after the Katmai eruption of 1912 could have been partly responsible for a warming of the atmosphere from 1920 to 1945, but again the relation between the two, volcanic dust and global warming, is not without ambiguity.

Cooling near the surface and warming aloft (stratosphere) is the result of scattering and absorption in different wavelengths. Warming of the stratosphere is usually an outcome of absorption in the infrared region by stratospheric aerosols. The cooling near the ground is usually small. This is due to the extinction of sunlight, which depends on the optical depth. It is partly off-set by scattering in the forward direction, that is, towards the ground. In view of their size, scattering by dust particles is more oriented towards the ground. This has been verified by observations in the period after the Mt. Agung eruption of 1963. First, a stratospheric temperature increase was observed by absorption of long wave radiation emitted by the earth. At a later stage, after the formation of minute H_2SO_4 drops by oxidation of sulphur and combination with water vapour, there was a net cooling near the Earth's surface by extinction of short wave solar radiation and forward scattering by H_2SO_4 droplets.

It is now possible to simulate these effects by mathematical models of the atmosphere's general circulation. Models enable us to find possible answers to a wide variety of questions. What will happen, for instance, to clouds and evaporation from oceans, if the lower atmosphere was cooled by a series of volcanic eruptions ? The general results, which are beginning to emerge, suggest the following sequence of events[2].

(i) Extinction of solar radiation makes the troposphere cooler. This leads to more cloudiness because of greater condensation of water vapour on condensation nuclei (aerosols) Clouds reflect sunlight, and also emit long-wave radiation back to space. Thus, there is an increase in outgoing radiation.

(ii) On the other hand, a decrease in solar radiation reaching the ground, coupled with tropospheric cooling, leads to a sharp decrease in evaporation and the water content of the troposphere. This tends to decrease cloud formation.

(iii) Decrease in the flux of latent heat of evaporation tends to decrease the north-south temperature contrast between the equator and the polar regions.

These geophysical feed-backs suggest interesting possibilities on which our understanding is still fragmentary. But, the indications are that the cooling at the surface will be greater at low latitudes, and its magnitude could be around 0.7°C. Will this counteract, partially, the greenhouse warming by fossil fuels ? What impact will it have on the summer monsoon rains over India ? The answers to such question are not yet available.

Another important aspect is related to interaction between volcanic dust and atmospheric ozone. Stratospheric warming after a volcanic eruption could lead to a decrease in the ozone content of the lower stratosphere by chemical reactions. Chlorine compounds, which are found in volcanic eruptions, could also help to destroy ozone. This could be of the order of 5 to 7 per cent. Depletion of ozone, which is a strong absorber of ultraviolet radiation, could have adverse physiological reactions on human life.

Monsoons and volcanic eruptions

Unfortunately, not much data are available on the size and distribution of aerosols over India. Systematic data were collected for a brief period during the International Monsoon Experiment (MONEX) of 1979, but they do not relate to the post-eruption phase of volcanic eruption. But, the dust load of the atmosphere over India does pose an interesting problem.

Theory suggests that the summer monsoon circulation is dominated by rising motion over north-east India and sinking, or descending, motion of air over Rajasthan and the semi-arid regions of northwest India. As descent implies the movement of air from lower to higher pressure, it must get warmed by adiabatic compression. But, as the air over Rajasthan is not getting warmer over the years, there must be some mechanism to off-set the warming by cooling. Theoretical computations suggest that, to maintain a steady monsoon, the required cooling rate should be about 2.4°C per day. At one stage, it was conjectured that this rate of cooling in the lower troposphere could be provided by a heavy dust load over Rajasthan. But, as we can see, heavy loads of dust following a volcanic eruption provide a cooling of only 0.7°C near the ground. This is not enough to balance warming by the descent of air. What other mechanism could provide the additional cooling over Rajasthan ? We do not yet have the full answer.

I wish to thank Professors B. B. Baliga and M. K. Das Gupta for asking me to prepare this article.

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RADIOLOGICAL PHYSICS*

A. K. DE**

I am very happy to be associated with this inaugural function when the first Post M. Sc. one year diploma course on Radiological Physics is being started by the Saha Institute of Nuclear Physics.

One of the functions of the Atomic Energy Regulatory Board (AERB) is to review and promote training programmes in the country in radiation safety for the peaceful use of atomic energy in applications such as the use of isotopes and radiation in health and medicine. I feel, therefore, particularly happy that AERB's initial proposal to the Saha Institute of Nuclear Physics about a year back and my discussion with Prof. M. K. Paul, Director, SINP in December last year has led to the start of the programme from this academic session. I am sure that this will fulfill a long felt need for trained manpower in Radiological Physics in the north-eastern region where there is no other such course. I would like to thank Prof. Paul and his colleagues for their enthusiasm and support in piloting the programme. Such a programme requires adequate facilities for field practices and I am glad to know that VEC, Calcutta and Cancer Centre and Welfare Home, Thakurpukur have taken keen interest and are participating in the programme. This will therefore be a unique experiment of collaboration and cooperation between these three institutions. On behalf of AERB I would like to thank the Director, Dr. Bikas Sinha, VEC and the Cancer Centre and Welfare Home, Thakurpukur Dr. Saroj Gupta for their interest and support.

I wish now to review the area in some detail. I shall try to cover the background in which a diploma course in Radiological Physics was first started in BARC, Bombay, the current status and the future scope. I shall also deal with other related areas in medical physics in passing. At the very outset, I would like to say that this branch of science has great scope in our country.

Realising the importance of manpower training for effective application of the various techniques now being developed, the Division of Radiological Protection, BARC has been organising a post-graduate training course in hospital physics and radiological physics since 1961. Initially the course was supported by the World Health Organisation which partly funded the course. A few sets of text books were provided by it in addition to arranging eminent professors from advanced countries to visit India and deliver lectures on several important topics. Trainees from a few developing countries also attended the course. The first batch of trainees came out in 1962.

From 1974, the course was recognized by the University of Bombay. Initially the course was designed on the basis of similar programmes conducted in Universities abroad. The syllabus has been revised and updated over the years and has been examined critically by specialists from WHO.

From the early sixties, there was a growing need for qualified physicists in radiotherapy departments. This was mainly because of the introduction of teletherapy units into the country. Most of these were gifted by Atomic Energy Canada Limited, the pioneers in the field, under the Colombo Plan. The diploma holders from D. R. P. got employed as medical physicists. Currently over hundred of them are employed as physicists in radiotherapy department. By virtue of their expertise, these physicists help the radiotherapists to ensure accurate dosimetry in treating cancer patients. Also many of them could participate in evaluating the performance of teletherapy and brachytherapy equipment.

During the past few years the requirement of radiological safety officers became mandatory. Government of India has established a teletherapy committee to examine the proposals for starting new teletherapy facilities. The post graduate diploma holders from the University of Bombay took up the

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* Inaugural Address at the Function of the Post M. Sc. Diploma Course at the Saha Institute of Nuclear Physics on 27th September, 1988

** Chairman, Atomic Energy Regulatory Board.

Future demand for Radiation Safety Offices/ Medical Physicists

Presently there are 155 teletherapy units in the country. These facilities are grossly inadequate to treat the 500,000 new cancer patients who present themselves for radiotherapy every year.

Most of the teletherapy units in the country are old; Safe use of these need the services of a conscientious band of professionals including medical physicists. In spite of acute paucity of funds, old teletherapy units are being replaced by more sophisticated teletherapy units and medical accelerators. Without employing qualified personnel these pieces of equipment are more dangerous. Remote afterloading equipment for brachytherapy is likely to replace the conventional treatment in many centres. These equipment need more qualified manpower including physicists for treatment planning and dose measurements. The regional distribution of facilities is also totally unsatisfactory. The facilities are likely to be augmented to ensure equitable distribution.

Most of the medical colleges in India are not equipped with teletherapy equipment. Central Government has plans to establish the facilities more extensively. A five fold increase in the number of teletherapy facilities is required in the coming decade. One Unit for just over a million population is expected to be reasonable. There will be a proportionate increase in brachytherapy facilities also. It is essential to train about a thousand physicists/RSO in the coming years.

Urgent necessity of accurate treatment planning and allied medical physics services are being appreciated by oncologists.

The life time cancer mortality in India is about 7% now. A fourfold increase in this number is expected by the turn of the century when the average life expectancy increases. The cancer detection rate also is likely to show dramatic improvement because of screening programmes funded by government and voluntary agencies. It is reasonable to expect that more and more patients with better prognosis will present themselves for treatment in all hospitals. Radiotherapy will thus continue to be a very popular mode of treatment.

There is a growing awareness among the cancer specialists about the need for establishing teletherapy facilities where only brachytherapy exists now. This is because both facilities are essential to offer curative rather than the more often employed palliative treatment to the thousands of women suffering from the cancer of the uterus and cervix.

The recommendations to establish separate department of radiodiagnosis and radiotherapy is being accepted in all institutions.

The requirement of medical physicists/RSO is being met mainly from two sources now. About 15 post graduate diploma holders from the University of Bombay and six M.Phil. degree holders from the Anna University, Tamil Nadu come out every year. This is obviously inadequate. Some of the diploma holders from the University of Bombay join the industry because of better prospects.

The post M.Sc. diploma course which will be started shortly here at the Saha Institute of Nuclear Physics, Calcutta is, expected to supplement manpower in the entire north-eastern region.

Medical physics is an applied branch of physics in which techniques and principles of physics are applied in healing disease. The first important tool used in medical physics was the microscope. The discovery of X-rays and the isolation of radium are two important developments which gave tremendous impetus to radiological physics.

Measurement of radiation dose was probably the first challenge taken up by physicists. Technological improvements led to the manufacture of powerful X-ray machines with high energy.

The first few decades of radiological physics saw the application of radium in treating cancer. Decades of experience accumulated systematically was applied to formulate the famous Parker-Patterson rules of radium dosimetry.

During 1930's the duty of medical physicists in many institutions used to be as Prof. Mayneord declared once "to save radium capsules from the tender mercies of incredibly muscular surgeons and in peacetime worry about how to measure Roentgen".

The advent of the Atomic Age brough in its wake, dozens of useful radioisotopes which found ready application in medicine.

Imaging technology in diagnostic radiology and nuclear medicine threw open a wide variety of tools to the physicians. Advances in computer hardware and software inspite far reaching changes in the treatment and diagnosis of diseases.

The progress in medical physics from microscopy to magnetic resonance is yet to make its impact in India.

As in other developing countries in India also medical physics continues to be radiological physics. As on September we can see the status in this field as follows :

Teletherapy centres	...	96
Teletherapy units	...	155
Brachytherapy centres	...	60
Remote afterloading	...	23
Nuclear medicine centres	...	86
Gamma camera	...	27
No. of hospital physicists	...	149
No. trained in DRP	...	105
No. trained in Anna Univ.	...	15
Others	...	29

We have to go a long way. Medical physics is not radiological physics alone. We must develop other disciplines in medical physics which should include ultrasonography, electroencephalography, thermography, myography, cardiophysics and all other branches of physics in medicine.

I am sure as this course progresses it will slowly bring also the other disciplines to make it up-to-date. I wish the course all success. I have great pleasure in inaugurating the course. □

Notes and news

India Marches ahead in SSNTD Research

The era of Solid State Nuclear Track Detectors (SSNTD) began in 1963 when Fleischer, Price and Walker developed chemical etching technique to reveal fission fragment tracks in minerals. During the last 25 years, SSNTD have invaded the research laboratories all over the world. They find applications in such diverse fields as geochronology, nuclear physics, space science, nuclear medicine and biology, radiation dosimetry, reactor physics and exploration geophysics.

SSNTD have a lot of potential for exploitation in Third World countries. Perhaps, this is the only technique which does not need any sophisticated equipment in some of its inter-disciplinary applications. An example from my personal experience will be useful to illustrate this point.

SSNTD research was originally confined to TIFR, Bombay in the early sixties. At present, about a dozen active groups are engaged in SSNTD research. The first national level meet was held at BARC, Trombay in March, 1979, through the bold initiative of Dr. R. H. Iyer. Only ten invited papers were presented at this meeting. The greatest achievement of this first national workshop was to identify the active SSNTD groups or individuals and to initiate a dialogue between them for a concerted effort. It was also decided that national level seminar cum workshops will be held every two years to promote the culture of SSNTD in India.

Fifth SSNTD national seminar was organised in March, 1987 at Calcutta. It was a three day meet where SSNTD workers from all over India participated in its deliberations. It was gratifying to note that seventy five abstracts were contributed at this conference, covering almost all areas of SSNTD application, a spectacular progress indeed in less than a decade. The highlight of 5th national seminar was Indian Cosmic Ray Experiment "ANURADHA" and about 10 papers were contributed by Professor Biswas and his co-workers from TIFR, Bombay and PRL, Ahmedabad. However, the largest contribution of 15 abstracts was made by SSNTD group at Guru Nanak Dev University, Amritsar. It was decided to hold the Sixth National Seminar at Gauhati in March, 1989.

To review our progress at SSNTD International Conferences, it is pertinent to remark that Indian participation began with the Tenth International Conference held at Lyon in France in 1979, the year we held our first national workshop at Trombay. India contributed only 5 papers at this meet. There has been a steady growth of Indian Contribution and participation at the successive International SSNTD conferences. We contributed 8 papers at 11th International Conference held at Bristol (U. K.) in 1981, an equal number at the 12th International Conference held at

TABLE 1 : What do they contribute to 14th International Conference on SSNTD, Lahore (Pakistan), April 2-6, 1988

Sl. No.	Country	No. of Papers
1.	Algeria	03
2.	Argentina	01
3.	Australia	02
4.	Bahrain	01
5.	Bangladesh	03
6.	China	12
7.	Coasta Rica	01
8.	Egypt	02
9.	France	10
10.	Germany F. R.	26
11.	Germany D. R.	02
12.	Greece	02
13.	Hungary	04
14.	India	44
15.	Iran	06
16.	Ireland	03
17.	Italy	11
18.	Japan	07
19.	Libya	01
20.	Malaysia	01
21.	Mexico	09
22.	Pakistan	28
23.	Saudi Arabia	03
24.	South Korea	01
25.	Spain	02
26.	Sweden	01
27.	Thiland	01
28.	United Kingdom	11
29.	U. S. A.	06
30.	Yugoslavia	07
	Total	211

Acapulco (Mexico) in 1983. 25 papers at the 13th International Conference held at Rome in 1985 and 44 papers at the 14th SSNTD International Conference held at Lahore in April, 1988. Thirty countries participated at this International meet and a large number of them are Third World countries. It is evident from Table 1 that the potential of SSNTD technique has been realised by developing countries of Asia and Africa. It is a matter of pride that India scored the top position at this International conference on the basis of the number of papers contributed. Again, the largest contribution was made by SSNTD group of Guru Nanak Dev University, Amritsar with nearly two dozen research papers contributed by 16 SSNTD workers. Unfortunately, most of the Indian contributors could not participate at this conference due to visa restrictions.

Some of the interesting features of the 14th International SSNTD Conference held at Lahore are depicted in Table 2. It is evident that the most fundamental question in SSNTD-the nature of latent damage track-still defies solution. The popularity of CR-39 plastic detector with SSNTD workers is ever on the increase though better varieties have also appeared in the market with prohibitive cost. Radon studies and Heavy Ion interactions are the other two areas most popular with SSNTD workers all over the world. Anomalon experiment results presented by Marburg group (W. Germany) was another highlight at this International conference. The 15th International Conference will be hosted by Marburg University in 1990. ☐

TABLE 2 : Trends in International SSNTD Conference

Sl. No.	Theme	No. of Papers
1.	Methodology	56
2.	Electro-chemical Etching	16
3.	Track Annealing	16
4.	Heavy Ion Reactions	38
5.	Neutron Dosimetry	20
6.	Radon Studies	34
7.	Geological Dating	14
8.	Diverse Applications	17
	Total	211

H. S. Virk

IOL to set up liquid hydrogen plant

In collaboration with Air Liquide of France, the Calcutta based Indian Oxygen Ltd. (IOL) proposes to set up a Rs. 15-crore project to produce liquid hydrogen to meet the rising needs of the Indian Space Research Organisation (ISRO). The project marks IOL's entry into space-research related sector with long-term aims in view.

Disclosing this to newsmen here, the IOL Managing Director, S. B. Budhiraja, said the project might be located near Sriharikota in Andhra Pradesh or somewhere in Tamil Nadu. The company has already received a letter of intent from the Union Government and the project is slated to start commercial operation in 1990-91 according to IOL's tentative projections.

The new project will have a production of 700 gm a day of which the ISRO's daily offtake will be about 500 gm. The commerical market for liquid hydrogen is limited in the domestic sector but demand is expected to grow when the optic fibre industry expands its capacity. ☐

The Hindu

Pests threat Plantation of trees

As a part of a huge agroforestry programme, several millions of leucaena trees are now growing in India. But its plantation is threatened by a pest that has reached India from Sri Lanka. Scientists monitoring the spread of the pest reported that it is widely spreading through Tamil Nadu.

Scientists of the Commonwealth Agricultural Bureau International Institute of Biological Control while monitoring the spread of the pest since it appeared outside its dwelling place in Hawaii in 1984 revealed that the pest which is native to Central America poses a threat to India. Scientists monitoring the progress of *Heteropsylla cubana* also confirmed that the pest is spreading through Tamil Nadu.

It is further apprehended that the spread of the pest may be wide in the near future especially by the influence of this year's monsoon helping to carry out pests to India. This attaches a special concern.

At present, about 500 tonnes of leucaena seeds have been distributed to the farmers in India. Scientists believed that the pest might spread widely. So leucaena trees threaten India. □

P. C. Bhattacharyya

National Symposium on Plant Science Research : Present Status and Future Challenges

The department of Botany, Punjabi University, Patiala is organising a three-day national symposium on the university Campus from August 28-30, 1989. The deliberations will pertain to the following major themes :

(1) Plants and Environment; Pollution and Conservation of germ-plasm.
(2) Taxonomy, phylogeny and Bio-systematics.
(3) Genetic variability, manipulations and Biotechnology.
(4) Plant morphology, Functions and Tissue-culture.

Persons desirous of participating in the symposium should contact the convenor, Prof. M. L. Trivedi, Head, Department of Botany, Punjabi University, Patiala 147 002, before December 15, 1988. The following schedule will be observed :

1. Last date for receipt of Abstracts : December 31, 1988 (in duplicate and not exceeding 200 words).
2. Last date for receipt of full papers : January 31, 1989 (in duplicate).

All the participants will be required to pay a registration fee of Rs. 150/- (Rupees One hundred and fifty). □

Faster, powerful superconductive devices

Toshiba Corporation has developed the technology to make superconductive devices much faster and more powerful than the silicon based memory and logic chips now in use.

A Toshiba spokesman said that the company's research group had improved upon technology developed a year ago to create a superconductive [illegible] copper and [illegible] bombarded with ar[illegible] covered with a layer of silver to prevent deterioration of the films surface.

The Toshiba technique was found to make possible creation of a 700-nanometre-thick, three-layer sandwich in which the centre layer is an insulator, surrounded by superconductive outer layers. Together they create a tunnel junction effect in which electrons are free to flow, virtually without resistance. The property of the materials is such that the flow of electrons is gradually shut off when current is applied below a set level and suddenly resumes, when the current is increased above a set level, enabling use of the compound as an off-on switch.

The silver layer was also found to attain superconductive properties when used in the compound at minus 193°C.

Superconductors typically operate at extremely low temperatures in which the properties of materials are altered to offer no electrical resistance. The ability to manipulate the speed of electron movement predictably is the heart of semiconductor technology. Materials with superconductive properties, such as yttrium, nyobium or gallium, are unstable, however deteriorating when exposed to the air. □

Asahi News Service

Efficient overall use of energy

In Japan, not only industry but also small businesses and ordinary citizens are becoming increasingly interested in raising the efficiency of energy utilisation.

In the case of large-scale power generation by power companies, as much as 60% of energy input is dissipated in the form of waste heat. Energy loss also occurs during power transmission. What all this means is that current power generation methods are not very efficient. Precious energy resources

Moreover, because electric power must be transmitted from locations far from the site of consumption, natural disasters or accidents can cause great disruptions.

Instead of relying on mammoth electric-power stations, it is more effective if power plants are dispersed. The cogeneration system generates electricity using a gas or diesal engine and uses waste heat for space heating or providing hot water. Thus, the cogeneration is able to make effective use of approximately 80% of the energy of fuel put into power generation.

Consumers of large amounts of both electricity and heat can better appreciate the merits of cogeneration. It appears that many hotels, hospitals and swimming pools, which require large amounts of thermal energy, have adopted cogeneration systems.

Cooling accounts for half of the annual thermal needs of hospitals, followed by the supply of hot running water and space heating. In hotels, thermal needs for hot running water are the greatest, followed by heating and cooking. The current trend among hospitals and hotels is to determine the optimum energy utilisation system by taking into consideration the particular characteristics of their heating needs.

While gas companies are promoting cogeneration, electric power companies are putting stress on an energy saving system that uses "clean and safe electricity". Power companies recommend that big establishments like office buildings use accumulator-heat pumps and that individual homes use electric water heaters to boil water with low cost midnight electricity.

One model house "Eletopia", has a living room with floor heating, double-paned solar windows, a nursery where plugs can be moved at will, and a kitchen where suspended shelves can be electrically raised and lowered. It even features a gadget called a "cockroach shocker" to electrocute cockroaches with two nine-volt batteries.

It is also equipped with a system to recycle exhaust heat from a refrigerator or air-conditioner and waste heat from heating bath water and use it as a source of heat to supply hot running water. Such innovative ideas allowing efficient over-all use of energy through the use of waste heat from cooling and heating are found throughout the home.

The Tokyo Electric Power Company is putting efforts into the development of "fuel cells" which represent the future of cogeneration. Unlike a cogeneration system that uses gas or petroleum, the technology invloved in the fuel cell is the generation of electricity by reversing the electrolysis process. It has been dubbed the "fourth" energy source, after hydrothermal and nuclear systems. Both electrical power and gas companies are making every effort to commercialise fuel cell technology. □

Tokyo News letter

Indian National Science Academy

The Indian National Science Academy invites applications from Scientists for partial financial assistance to participate in important Scientific International Conferences abroad during the year 1989-90. Scientists interested to avail of financial support from the Academy for participation in International Conferences to be held during the year 1989-90 are requested to apply in the prescribed proforma. The proforma is available from the Office of the Executive Secretary, Indian National Science Academy, Bahadur Shah Zafar Marg, New Delhi-110 002.

The Scheme is operated under three different categories viz. : (1) For International Conferences sponsored by the International Council of Scientific Unions (ICSU) and its affiliated bodies (ICSU Conferences); (2) For International Conferences sponsored by other agencies (Non-ICSU Conferences); (3) For applicants who are interested in partial travel assistance only, for participation in any International Conferences abroad. The applicants must be below 35 years of age. This is categorised as INSA-COSTED Travel Grant.

Category 1 : Scientist who has been invited to deliver a plenary lecture/preside over a session of a scientific conferences or whose paper has been accepted for presentation, and who will also be provided maintenance allowance during his/her stay abroad and partial travel expenses by some agency, will be given preference over others. INSA's financial support, in case of selection is limited to a maximum of 50% International travel, 50% maintenance allowance for the duration of the conference and registration fee, wherever necessary. The prescribed application form duly completed should be despatched latest by

31st January each year for consideration by a Committee of the Academy during the year.

Category 2.: Scientist who has been invited to deliver a plenary lecture/preside over a session or whose paper has been accepted for presentation and who will also be provided maintenance allowance during his/her stay abroad and partial travel expenses by some agency, will be given preference over others. INSA's financial support in case of selection is limited to a maximum of Rs. 5,000/- only. Applications for this category should be received in the Academy for consideration three months prior to the date of commencement of the Conference.

Category 3.: Under this category the scientist who is interested to avail partial travel assistance only, for participation in any International Conference and is also below 35 years of age may send his/her formal request on a prescribed application form atleast three months prior to the date of commencement of the Conference. The applicant should fulfill the following eligibility criteria before sending his/her application :

(a) His/her age should be below 35 years on the date of commencement of the Conference.
(b) He/she should hold a Doctorate degree.
(c) His/her paper should have been accepted for presentation.
(d) His/her local hospitality and partial travel expenses has to be borne by the organisers or some other agency.

Candidates selected will be supported partially for their travel cost, jointly by INSA and COSTED (Committee on Science & Technology in Developing Countries). The applications will be screened once a quarter during the year.

☐

Food from Ornamental Weed

Amaranths, usually considered weeds or ornamentals in the western world, are now being developed for use in new food products by botanists and nutritional experts at Hebrew University's Faculty of Agriculture in Rehovot, Israel.

Naomi Trostler, of the University's School of Nutritional and Domestic Sciences, specialises in the development of high-protein foods and supplements for persons on special diets. In the past, she pioneered the development of cotton-seed flour for use in a line of such products. At present, she is working on the similar collaboration with Jaime Kigel of the Department of Agricultural Botany.

Amaranth seeds resemble tiny spheres and are about the size of mustard seeds. The plants are 1.2-2.4 m, with a bushy seed head. Some species possess showy flowers (Cock's-comb) and are cultivated ornamentally, while others are noxious weeds. Still a few species have been used as food plants in Central America for thousands of years and are today raised in remote corners of Africa and Asia. These are the species attracting the attention of Trostler and Kigel.

Amaranth grain has the merit of containing protein of a high biological value, being low in fat and without lactose, which certain people cannot digest. Devoid of gluten, amaranth flour can be digested by celiac patients allergic to this component of wheat flour. Malnourished long-term chronically ill patients and elderly invalids, who have difficulty in consuming the amounts of food needed for proper nutrition, will find it a boon. The whole grain is rich in dietary fibre and the plant yields heavily even in low-rainfall belts.

The two researchers have already successfully grown an experimental plot of amaranth grain, carried out studies on animals of the grain's nutritional qualities, identified certain digestive inhibitory factors and found how to eliminate them and experimentally prepared and tested several food products.

Bread that they made with one part of amaranth flour and three of wheat flour was known to be tastier than ordinary bread and much more nutritious, as the amaranth flour contains lysine, an essential amino-acid absent from wheat flour. They have also prepared a tasty porridge from it and noted that the grain can be served like rice and popped for a granola mixture. ☐

Hebrew University News

Roaring to reproduce

Male bird song during the breeding season is known to affect male-male competition as well as mate selection and ovulation in females. Though some male mammals also call loudly and frequently during the breeding season, until now these calls were known to affect only competition between males. But in a recent study of farmed red deer (*Cervus elaphus*) in New Zealand, Karen McComb of the Large Animal Research Group of Cambridge, UK, demonstrated that roaring by red-deer stags advances the date of ovulation in hinds. McComb compared ovulation dates in three experimental groups of females—one that heard tape recordings of male roaring, one exposed to vasectomised males (which, although infertile, exhibit normal rutting behaviour) and one control. The groups exposed to tape recordings and vasectomised males both came into estrus earlier than did controls. Speculating why females would have been selected to respond to male roars, McComb stated that the behaviour could have evolved to prevent females, which come into estrus for less than 24 hr, from ovulating when no rutting males were around. "The experiment procides the first evidence that malevocalisation can affect the timing of ovulation in female mammals." □

Bioscience

Fossils of giant "toothed" seabird unearthed

Fossils of the largest known flying seabird have been described by scientists at the Charleston Museum in South Carolina and the Smithsonian Institution's Museum of Natural History in Washington, DC. Discovered in a block of hardened sand and silt excavated in South Carolina in 1984, the recently analysed fossils reveal that the bird, now extinct, weighed about 90 lb and had a wingspan of over 18 ft. The largest living seabird, the wandering albatross, weighs 20 lb and has a wingspan of 11 ft. The extinct bird's wing structure shows that it had a life-style similar to that of the albatross. While both species' shoulders would allow them to raise and lower their wings, the peculiar shoulder structure also restricts the rotational movement necessary for flapping. When albatrosses forage, they use oceanic winds to soar great distances with little or no flapping. The recently discovered bird was a member of an extinct family, pseudodontrons, known as bony-toothed birds because they had long tooth-like structures protruding from their upper and lower jaws; the "pseudo-teeth" were not real teeth, because they were made entirely of bone rather than containing some dentine and enamel. Although scientists do not know why pseudodontorns became extinct, one hypothesis is that, as they relied so heavily in oceanic winds, the birds could no longer survive when ocean currents and wind patterns changed. □

Bioscience

Methane Build-up

Much more methane than expected is reaching the atmosphere from "fossil" sources, such as coal mines and natural gas than previously thought. The amount of methane in the atmosphere is increasing at a rate of 0.8% a year and its concentration from 650 ppb 200 years ago to nearly ppb today.

Swamps produce methane naturally, as do paddy fields, which are, in effect, artificial swamps. Farm animals also produce methane. Some methane also escapes from coal mines and some is released as "natural gas" from oil and gas fields that are exploited commercially. Estimates of how much of this fossil methane gets into the air have been vague— until now.

David Lowe and colleagues at the Institute of Nuclear Science of Lower Hutt, New Zealand, have studied the composition of atmospheric methane. They measured the amount of ^{14}C the gas contains, the half-life of radioactive carbon being 5,730 years. Methane from coal and gas fields contains none of this isotope. The proportion of ^{14}C, compared with other isotopes of carbon in the methane samples, suggests that 32% of the methane now reaching the atmosphere comes from fossil sources. This is about four times as □

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Science Corner

Articles published in this section are for students and general readers for understanding science in the perspective of its fundamentals. We invite Science teachers and scientists for contributing articles to this section. Also we shall appreciate comments from our readers on the articles published in this section.—*Ed.*

THE HUMANIZING OF NATURE

SANAT K. MAJUMDER*

Long before organized knowledge appeared on the scene, human cultures sought guidance from myths, folklores and traditional values. This is particularly evident in man's relationship with unknown and uncharted Nature. Despite the prevailing scientific sophistication, contemporary societies are not bereft of myths. Different socio-political pre-occupations, existing among various human cultures today, have fueled many myths in the form of sweeping rhetoric and half-truths—especially in relation to environmental issues and the conservation movement.

CONTRARY to popular belief, myth and folklore are not limited to the primitive human culture. The *productive chaos* of trial and error in which our ancestors found themselves, continues to exist today and create modern "myths"—as colourful, controversial and inevitable as ever ! I shall attempt to illustrate my point from the studies of human interaction with Nature and the environment.

At the outset, I should assure the readers that myth is not necessarily an evidence of ignorance. Instead, it reflects our imaginative effort to size up reality in human terms. For instance, long before organized botanical knowledge appeared, our socio-religious bias dominated the perception of plant life. Expressions such as "palms" of victory, "lily" of purity, "willowy" grace, and "olive" branch of peace entered our vocabulary. Similarly, ignorant of the existence of cotton-bearing plants, Europeans visualized a "vegetable lamb" of the East (wool-bearing plant)!

Originating in China and spreading into Europe through the Middle Ages, *The Doctrine of Signature* insisted that the appearance of a plant (or its parts) was a guide to its medicinal utility prescribed by God[1,2]. A case in point is the herb, Mandrake (*Nightshade* family or solanaceae) the roots of which resemble human limbs. While this legendary plant did yield precious pain-killing drugs, not all Divine "*Signature*" withstood scientific scrutiny. And yet, the human probe of the unknown always embraced as the starting point half-truths and harmless inaccuracies.

Different socio-political urgencies that exist in human culture fuel many such myths even today. Examples can be found in the sweeping rhetoric dealing with, for instance, "environmental movement", "population bomb" and "conservation". Let us, for clarity, expand on the last topic—conservation.

The current global view of environmental crisis is not a pretty one. The cumulative human impact on our natural resources (water, fuel, minerals, top soil, forest, as well as rare species of plants and animals, etc.) is enormous. True, environmental problems are not new historically ; rulers of ancient Egypt, Babylon, Assyria and China had no rivals in their exploitation of land and forest. Even Plato in his *Critias* spoke of deforestation and over-grazing as causes of soil erosion. Needless to say, the machines of destruction today are more powerful than ever.

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It is obvious that in order to protect our investment in Nature, we must *conserve* our natural resources. Is *conservation* the same as *preservation* of everything under the sun ? It is doubtful. We do not conserve magnificent redwood trees for the sake of these trees; we save them in the unabashed selfish interest of human beings and their posterity. In the amoral and apparently wanton Nature, the rhinos and the Royal Bengal tigers, the bald eagles and the whooping cranes, become manifest only as human essence envelopes them with meaning[3].

This brings me to what I consider the most intriguing of all myths about the human role in the ecologically-impacted non-human world: that man should be viewed as a "planetary disease", an "epidemic"; that he is "necrotic pathological tissues walking around pretending to be man"[4] ! Counterproductive in its missionary zeal, this chastizing sanction leaves us with little choice : either self-righteousness or an admission of our cultural inferiority. It is a "love-it-or-leave-it" slogan which the conservation movement must shun.

In conclusion, then, it can be said that myths are necessary products of the confluence between human cultural bias and the uncharted Nature. It is like being engaged in "collective bargaining" with a capricious Mother Nature in the interest of meaningful human progress.

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Letters to the editor

Effect of ambient temperature and detension period on the yield of biogas from water-hyacinth

Because of the world-wide energy crisis due to ever-increasing prices of crude oil, the unconventional energy resources are being fast mobilized. One of the important unconventional energy resources for India is biogas. The country has a large potential of biogas energy which can be obtained from animal dung and biomass such as crop waste, algae plantation, etc[1]. Biogas is obtained by anaerobic fermentation of biomass in a suitable digester. Currently, two types of anaerobic digester are generally being used for the production of biogas. The first type is known as KVIC (Biogas plant of Khadi and Village Industries Commission) with a moving mild-steel gas-holder. The second type is the Janta Biogas Digester which is a modified version of Chinese Biogas Digester. This model has a fixed dome for holding biogas. Out of these two models, the later one is likely to be more popular in course of time due to less recurring expenses involved in it besides marginally low cost at the time of installation[2,3]. The investigators have further modified the Chinese biogas plant by improving the flow conditions of water-hyacinth slurry and by changing the geometry of inlet. An attempt has been made to study the effect of ambient temperature with changing detention period on the yield of biogas under pressure varying from 50 to 700 cm of water column.

A biogas digester of 0.70 m^3 capacity was fabricated to conduct studies under field conditions. The model consisted of three good-conditioned mobil-oil drums welded to form a vertical type

Chinese digester. The digester was provided with a baffle wall across the diameter to improve the flow of water-hyacinth slurry through it. The top of the digester was closed by a welded lid. On this lid, the outlet of gas, the device for measuring pressure, etc. were suitably welded.

The digester was fed with water-hyacinth slurry and anaerobic methane-producing bacteria and kept for 30 days for initial fermentation. During this period, no observations were taken. Subsequently the digester was fed with 4.5 kg of raw water-hyacinth slurry mixed with equal quantity of water. A certain level of slurry was always maintained at the time of feeding the digester. The gas empted twice a day, i.e. at 8.00 AM and 6.00 PM daily. The yield of gas was measured by the wet-type gas flowmeter supplied by M/S. Toshniwal. The temperature of the digester was measured at the bottom of the digester. The observations of the yield for one set were taken for 4 weeks.

The detention period of slurry was changed by changing the quantity of feed to the digester. When the feed was changed, observations were discontinued for about two weeks and subsequently observations were resumed in manner described above. The input feed was changed from 4.5 to 7 kg raw water-hyacinth slurry. The ambient temperature changed from 33°C to 25°C during the period under observations.

The regression analysis of yield/ kg of raw water-hyacinth and temperature was carried out in computer and best fit was selected out of exponential and polynomial functions. Out of all, the exponential function seemed to give a better fit curve to the observed data. The exponential relation found out could be mathematically represented as :

$$Y = a\,e^{b-x}$$

Where Y = Yield of biogas per kg of raw water-hyacinth

x = Ambient temperature in degrees centrigrade,

a & b are the regression constant.

The relationship between temperature and yield per Kilogram of raw water-hyacinth slurry is shown in Fig.1. The values of constant a, b, temperature and the corresponding exponential relation for different doses of feed are shown in Table1.

TABLE 1 : Exponential relationship between feed rate temperature

Feed (kg)	a	b	Temp. range°C
4.5	0.1321	0.1865	31 - 33
5.0	11.8120	0.0412	28 - 31
6.0	0.1060	0.2200	30 - 27.5
7.0	4.3100	0.0660	25 - 30

Average values of a = 4.087 and b = 0.1234

$Y = 0.132e^{0.1865x}$ (Temperature range 31 - 33°C).

$Y = 11.81e^{0.412x}$ (Temperature range 28 - 31°C).

$Y = 0.1060e^{0.220x}$ (Temperature range 30 - 27.5°C).

$Y = 4.31e^{0.66x}$ (Temperature range 25 - 30°C).

From Table 1, it is seen that the regression coefficients a and b vary with input dose of feed and ambient temperature. The changes in value of the coefficients may be attributed to changing volume of gas produced and different doses of feed and temperature. From Fig. 1, it can also be inferred that the fitness of the curve is fairly good and, therefore, exponential relation between temperature and gas yield is fair. From the Table 1, it can be inferred that:

(a) At each input dose, the yield of biogas increases as temperature increases.

(b) As the input dose was increased, the corresponding detention period decreased and as a

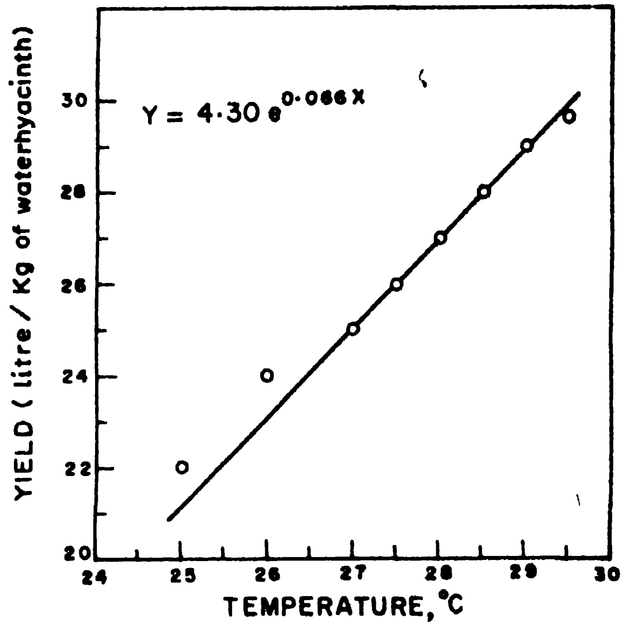

Fig. 1. Temperature vs yield of gas/kg of water-hyacinth

result of which yield of biogas per kilogram of raw water-hyacinth also decreased.

In order to further analyse the results for a constant detention period, it is assumed that yield of biogas increases linearly with increased in detention time. The biogas yield for different input feed was extrapolated linearly for detention time of 29 days which corresponds to feed rate of 7 kg of raw water-hyacinth. The extrapolated values of yield of biogas were calculated both for observed and theoretical relationship. From these, it was found that the rate of change of biogas yield/°C unit change in feed rate were 0.18 and 0.22 for observed values and theoretical relation respectively. From this, it can be further concluded that ambient temperature and yield of biogas can be approximately represented by exponential relationship.

From this study, it can be stated that biogas yield and temperature can be approximately represented by exponential relationship. It is further noted that biogas yield decrease in detention time.

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Occurrence of the exotic *Lantana* lace bug *Teleonemia scrupulosa* Stal. in the Anaimalai hills, Western ghats

Anaimalai hills (Western ghats) of Coimbatore district, Tamil Nadu, where the weed *Lantana* is a menance, overrunning range lands and plantations, was explored for the natural parasites of *Lantana*. Observations were made along a 50 km tract (alt. 280-1440 meters M. S. L.) along Aliyar Dam to Valparai and Attakatti to Kadamparai roads over a period [illegible] six months beginning June, 1987. In the course of evaluation of various pests, the *Lantana* lace bug *Teleonemia scrupulosa* Stal. (Hemiptera : Tingidae) was found to be widespread on the host *Lantana camara* var. *aculeata* in the study area.

The tingids were limited to the growing tender regions only and as the shoots grew, the bugs also tended to ascend the stems. They feed on the younger leaves, tender shoots, inflorescence and fruits. The bug is mainly found on the underside of the tender leaves over the veins. The initial effect of its feeding on *Lantana* was the yellowish or brownish discolouration and stunted growth in the shoot apex. This was followed by curling up, blighting and falling of leaves resulting in a burnt appearance. Apart from the leaves which were mostly fed upon, the flowers and fruits dropped prematurely and the maturity of the fruits delayed. Finally, the upper shoots died and with the onset of rain, newer leaves emerged from the lower parts which again were attacked. Thus, the vigor of *Lantana* bushes was suppressed and the reproductive potency severely impeded. The bugs were limited to *Lantana* and were not found to feed on any other alternative host in the study area especially other verbenacious members like teak.

The tingid *T. scrupulosa* appears to be more tolerant to extreme climate as evidenced by its presence throughout the study area ranging from 280 to 1440 meters of elevation from the mean sea level. The incidence of bush attack over various altitudes indicated that they are well adapted to higher temperatures prevalent at lower altitudes. However in the cooler places at higher altitudes, they preferably infested *Lantana* bushes growing in the open sun.

The history of *T. scrupulosa* in India could be traced to its import from Australia in 1941 for cage tests at Dehra Dun to assess its value against *Lantana*. Though found useful, they were subsequently destroyed for their potential threat to teak plants, especially their flowers[1]. Some tingids, probably got escaped, were spotted in *Lantana* bushes around Dehra Dun after a decade[2]. Subsequently, they were recorded in the sub Himalayan tracts of North India[3]. Later, during 1969-70, microrelease of the tingid was made in Hyderabad by the Plant Protection Training

Institute, that got established in the neighbouring state of Karnataka[4]. The present investigation records the tingids in the Anaimalai hills over varying altitudes.

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Cytological studies of *Manisuris myuros* Linn. of the tribe Andropogoneae

Manisuris myuros Linn. belonging to the sub-tribe Rottboellinae of the tribe Andropogoneae is a creeping grass with culms reaching a height of 6" to 2 ft. Bor[1] describes 5 species from India. Cytological information on this genus has considerable phylogenetic significance. Many authors[2], have stated that the sub-tribe Rottboellinae and the related tribe Maydeae have originated from a common ancestor. In some respects the floral morphology[3] of the tribe Maydeae is similar to the Rottboellinae and Anderson[4] suggested that *Tripsacum laxum* (Maydeae) is an allopolyploid with *Manisuris cylindrica* as one of its parents. Chandravandana and Galinant[5] also suggest that *Manisuris* is a connecting link between the Rottboellinae and the Maydeae. Celarier[6] considers the maydeae is probably derived from the Rottboellinae on cytological evidence.

The plants for the present study were collected in the wild from Marutvamala in Kanyakumari District. Root tips were fixed in 3:1 alcohol acetic acid and squashed in 1% acetocarmine. Somatic studies showed sixteen chromosomes which range in length from 4.0 to 7.5 μm (Fig .1). Seven pairs are median (m-type) and one pair is sub-median (sm type). The Karyotype is less specialised belonging to the category 1A. One pair possess satellite in the short arm.

Fig. 1. Root tip cell of *Manisuris myuros* (2n=16) (x 1500)

It is worthy of mention here that the members of the sub-tribe Rottboellinae and the tribe Maydeae are unique in possessing comparatively large chromosomes (3-8 μm) with less specialized karyotypes. In contrast grasses in general have very small chromosomes (1-2 μm in length). In floral morphology also, these two tribes resemble in some respects. Therefore the present study of the chromosome size and morphology of *Manisuris myuros*, strongly supports the cytological affinity of the members of the sub-tribe Rottboellinae and the tribe Maydeae.

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H_2O_2 metabolism during senescence of *Hydrilla* leaves under light and darkness

Hydrogen peroxide is a toxic metabolite[1] produced naturally during plant metabolism[2]. It may form in leaves of terrestrial plants during the activity of several oxidase enzymes[3]. A change in the level of H_2O_2 has been regarded as an important aspect of leaf development and senescence by several authors[4, 5]. It has been suggested that H_2O_2 has profound influence on senescence in excised leaves of rice[4,5] and sunflower[6].

During senescence, the activity of catalase decreases[5,7,8] resulting in several-fold increase in H_2O_2 level. Peroxidase is another enzyme involved in the catabolism of H_2O_2 and its activity is greatly increased during senescence[7]. The role of two H_2O_2 scavenging enzymes, particularly that of peroxidase, on senescence of terrestrial plants is still not clearly established. Moreover little is known about the H_2O_2

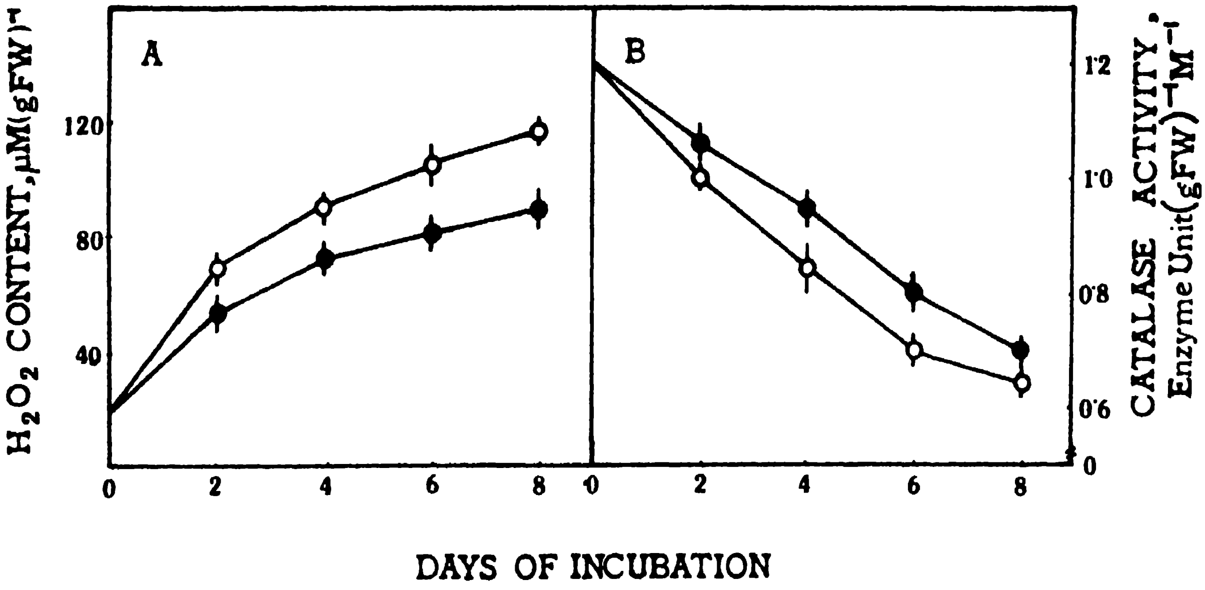

Fig.1. Changes in the level of H_2O_2 (A) and activity of catalase (B) in *Hydrilla* leaves during senescence in light (O) and darkness (●)

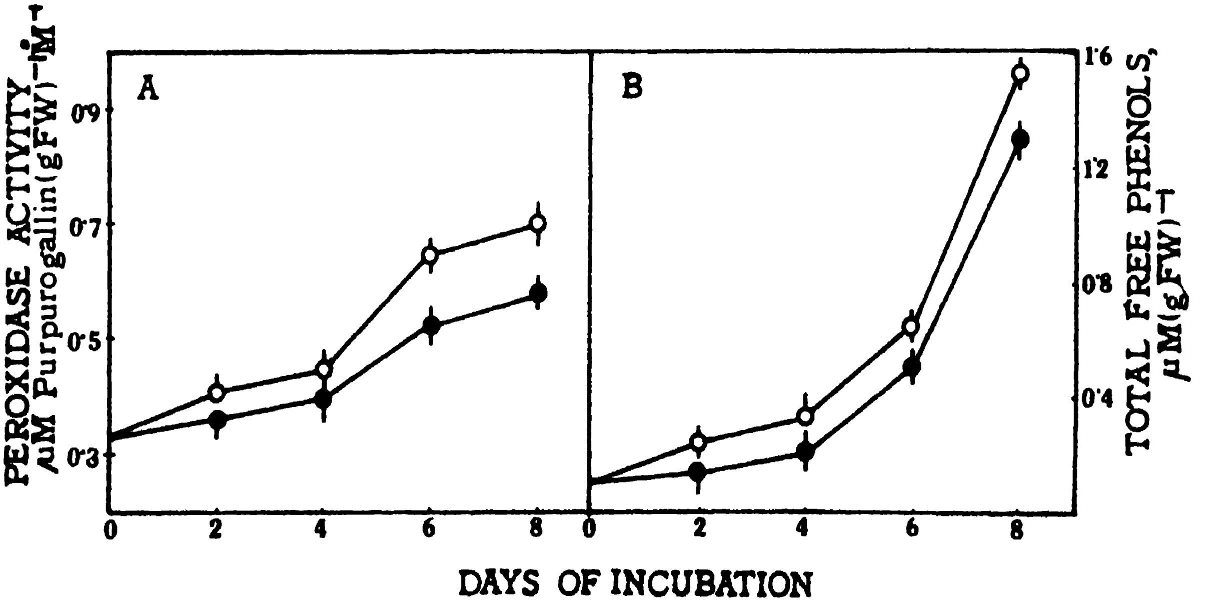

Fig.2. Changes in the activity of peroxidase(A) and level of total free phenols (B) in *Hydrilla* leaves during senescence in light (O) and darkness (●)

metabolism and leaf senescence in aquatic plants. In view of the above, the present investigation was designed to analyse the role of H_2O_2 and its metabolism during leaf senescence of *Hydrilla*, a submerged angiosperm, in both light and darkness. Attempts were also made to study the changing pattern of catalase and peroxidase activity during senescence of *Hydrilla* leaves in light and darkness.

Healthy mature twigs of *Hydrilla verticillata* (L.f.) Royle were collected from the tank maintained in the Department of Botany of Burdwan University and thoroughly washed with water. Surface was sterilized by rubbing leaves with cotton moistened with ethanol for a few seconds followed by immediate washing with distilled water to avoid desiccation[9]. Leaves from the subapical portions were isolated and carefully blotted to remove adhering water. Randomized leaf samples (400 mg) were floated in Petri-dishes containing water mixed with 17 μM streptomycin sulphate and 70 μM sodium penicillate to check microbial growth[10]. The leaves were then incubated in the dark or in continuous light (20 μ mol $m^{-2}S^{-1}$) in a temperature-controlled growth room (25 ± 2°C). After stipulated periods of incubation (0, 2, 4, 6 and 8 days), the leaves were washed thoroughly with deionized water, blotted and sampled for different analyses. Hydrogen peroxide (H_2O_2) was estimated in the leaf samples according to the method of Mac Nevin and Uron[11]. Activities of catalase and peroxidase were assayed following the methods described by Kar and Mishra[7]. Catalase activity is presented as enzyme unit $(g\ FW)^{-1}M^{-1}$ and peroxidase activity is presented as μM purpurogallin formed $(g\ FW)^{-1}M^{-1}$. The total content of phenolics was also determined from the alcoholic extract with the Folin-phenol reagent according to the method of Bray and Thorpe[12]. Each experiment was repeated thrice with three replicates in each set and the mean values are represented in Figs. 1 and 2. Standard errors (SE) were calculated[13] and plotted in the figures as bar.

The level of H_2O_2 in senescing leaves of *Hydrilla* increased to a greater extent in light than in the dark till day 8 (Fig. 1A). Light-induced increase in H_2O_2 level is now well documented[14,15]. According to Kar and Choudhuri[15], the light-induced accelerated degradation of chlorophyll in *Hydrilla* leaves is mediated through a phenol-specific peroxidase-H_2O_2 system located within the chloroplast.

Catalase activity decreased both in light and darkness with progress of senescence (Fig. 1B). Compared with darkness, the catalase activity was lower in continuous light. The decrease in catalase activity in *Hydrilla* leaves is in agreement with the earlier observation of Mondal and Choudhuri[16] and Patra *et al.*[8] in terrestrial plants. However, there are some reports which show that the activity of this enzyme increased in dark-incubated excised leaves of wheat and barley[17,18]. Hence, it has been suggested that the change in catalase activity during senescence is species-specific[8].

Peroxidase activity of *Hydrilla* leaves increased with time, but the increase was more significant on day 6 and 8 in light than in darkness (Fig. 2A). The increase in peroxidase has also been noted previously for a variety of senescing plant tissues[7,19,20] although its role in senescence is not well understood. Birecka *et al.*[19] suggested that increase in peroxidase may be an induced protective reaction to delay senescence. There are also suggestions that tetrameric catalase molecules break to form monomeric peroxidase molecules[21], resulting in several-fold increase in peroxidase activity during senescence[20,22]. A sharp rise in peroxidase activity in *Hydrilla* leaves in light indicates that this isoenzyme is influenced by light[23].

The increase in total free phenolics during senescence was observed in both light and darkness, but the effect was more pronounced in light on day 6 and 8 than in darkness (Fig. 2B). This increase may be accounted for as due to the release of phenolics from the leaky vacuoles and the liberation of the phenolic amino acids from proteolysis[7].

From the above results, it is found that H_2O_2 metabolism is an integral part of leaf senescence of *Hydrilla*, as it is in case of terrestrial plants.

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Metabolic status of the *Athyrium* frond during vegetative and fertile phase

Metabolic changes during vegetative to reproductive phase have been investigated largely in angiosperms[1] while such studies in pteridiphytes have been sparse and relate to quantitative variations in the free-amino acid pool during spike initiation in some species of *Ophioglossum*[2]. The present investigation deals with quantitative variations in sugar, total free-amino acids, lipid, phenol, starch, protein and phosphorous and qualitative differences in free- and bound-amino acids in sterile and fertile fronds of *Athyrium falcatum* Bedd.

Sterile fronds of *A. falcatum* were collected from Mt. Abu (Rajasthan) in August, 1986 when the plants were in the vegetative phase and fertile ones in October, 1986 after the onset of reproductive phase. Sugar[3], protein[4], phenol[5], starch[6], lipid[7], phosphorous[8] and free-amino acid[9] were quantitatively estimated by standard methods in both sterile and fertile fronds. Free- and bound-amino acids were qualitatively determined by paper chromatography[10-12].

The fertile fronds were found to contain higher quantities of sugar, protein, phenol, starch and total free-amino acids (Fig. 1). The quantity of lipids and phosphorous was, however, seen to be reduced in a fertile frond (sporophyll) in comparison to vegetative frond. Besides, the amino-acid content of the fertile and vegetative phase exhibited qualitative variations. Thus, glycine and hydroxyproline in free form and serine in bound form were found to be exclusive to sporophylls. Similarly, threonine in free

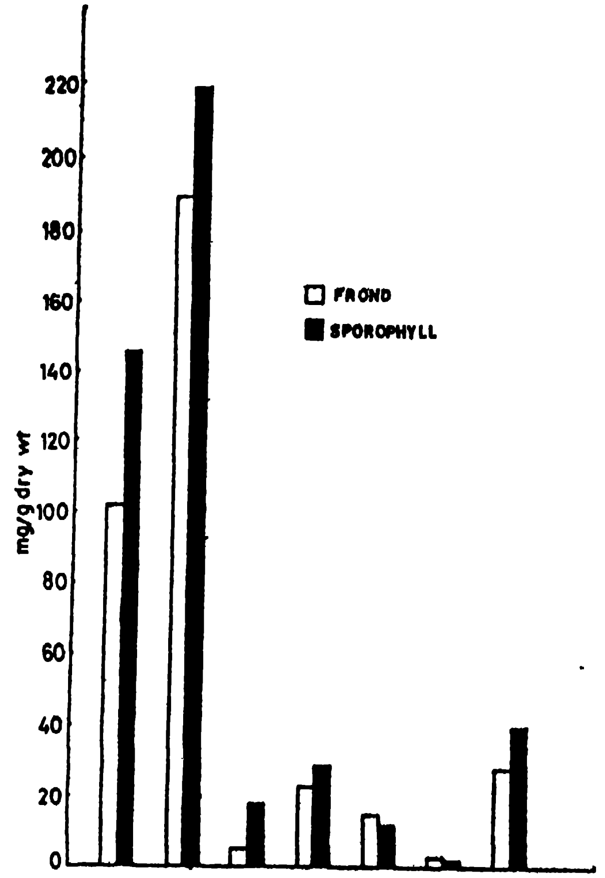

Fig. 1. Quantitative variations of metabolites in the sterile (frond) and fertile (sporophyll) leaf of the fern *Athyrium falcatum* (1 sugar, 2 protein, 3 phenol, 4 starch, 5 lipid, 6 phosphorous, 7 free amino acid)

form and tyronine in bound form were restricted to sterile fronds. Cystein provided interesting variations, occurring in bound form in the vegetative frond and in free form in the sporophyll (Table 1).

TABLE 1 : Variations in free and bound amino acids (qualitative) of the frond and sporophyll in *A. falcatum*

Free-amino acid		Bound-amino acid	
Frond	Sporophyll	Frond	Sporophyll
Lysine	Lysine	Arginine	Arginine
Ornithene	Ornithene	Tyronine	-
-	Glycine	Methionine	Methionine
-	Hydroxyproline	Proline	Proline
Threonine	-	-	Serine
-	Cystein	Cystein	-
Isoleucine	Isoleucine	-	-

Quantitative escalation of sugar, protein, phenol, starch and total free-amino acids indicate an enhancement of metabolic activity consequent to the onset of reproductive phase in this fern. This increase in metabolities may also be due to the mobilization of soluble nitrogen and other compounds during the transformation of the plant from vegetative to reproductive phase. It is relevant to mention here that translocation of nutritive substances, specially sugar and amino acids from vegetative tissue to the ovules is known in many angiosperms[13]. So also the appearance of glycine and hydroxyproline in free form and serine in bound form, while the elimination of threonine in free form and tyronine in bound form in the sporophyll (fertile phase of the frond) is a manifestation of a change in amino acid pool of the plant during reproductive phase. Glycine and hydroxyproline in free form and serine in bound form may have an important role to play in enhancement of the metabolic activity consequent to initiation of reproductive structures (sporangia) in this fern. Similar studies in other ferns of Rajasthan during the change from sterile to fertile phase are being investigated in this laboratory in order to arrive at conclusions regarding the metabolic status of pteridophytic plants.

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Varietal preference of ber fruit-fly, *Carpomyia vesuviana* Costa. against different ber cultivars, *Zizyphus mauritiana* Lamk. at S. K. Nagar, North Gujarat

Ber (*Zizyphus mauritiana* Lamk.) is one of the most ancient and common fruits of India. It is very popular among rural Indians from time immorial. In India ber is being cultivated in an area about 22,000 hectares and widely grown in the plains of Punjab, Uttar Pradesh, Haryana, Rajasthan, Andhra Pradesh, Tamil Nadu and West Bengal[1]. In Gujarat the land under ber cultivation is about 4100 hectares, mostly in the semi-arid zones of the State[2]. In India about 125 varieties of ber are grown in different States and the main varieties in vogue in Gujarat are Gola, Mehrun, Umran, Ajameri, Chameli, Randeri[3] etc.

Among the various constraints in successful ber production, the insect attack form the prime importance of which ber fruitfly *Carpomyia vesuviana* Costa, is the most serious and has been proving a limiting factor in cultivation. Its attack not only reduce the yield but also adversely affects the quality of fruits. The persistant menance of this pest has been reported to spoil up to 100 per cent ber fruits in South

India[4] and not less than 80% in Delhi[5] and at times even as high as 100 per cent of ber fruits in Rajasthan[6]. Hence considering the economic status of ber fruit-fly a study was conducted at Sardar Krushinagar Campus of Gujarat Agricultural University to screen the existing ber varieties against this pest to detect the resistance if any, during 1986-87.

TABLE 1 : **Per cent damage of ber fruit-fly in different ber varieties during different picking at Sardar Krushinagar (1986-87)**

Varieties Period	Per cent fruit-fly damage Gola	Seo	Seb	Mundia	Umran	Chameli	Local	Mean for period
21st January	43.04 (46.58)	29.18 (23.77)	32.80 (29.34)	26.69 (20.17)	32.56 (28.96)	50.56 (59.64)	25.48 (18.50)	34.33 (31.80)
4th February	37.80 (37.56)	23.85 (16.34)	26.25 (20.54)	21.75 (13.73)	27.24 (20.95)	36.38 (35.18)	20.40 (12.15)	27.77 (21.71)
18th February	30.09 (25.13)	21.12 (12.98)	23.52 (15.92)	20.57 (12.34)	24.78 (17.56)	27.38 (21.14)	18.39 (9.95)	23.69 (16.14)
4th March	28.91 (23.37)	20.75 (12.55)	23.30 (15.64)	18.74 (10.32)	24.16 (16.75)	21.10 (12.95)	17.97 (9.52)	22.13 (14.19)
18th March	35.15 (33.14)	27.41 (21.19)	32.94 (29.56)	26.26 (19.57)	32.78 (29.31)	36.73 (35.76)	24.74 (17.51)	30.86 (26.31)
Mean for variety	35.0 (32.89)	24.46 (17.14)	27.90 (21.89)	22.80 (15.01)	28.30 (22.47)	34.43 (31.96)	21.4 (13.31)	—
			S. Em.		C. D. at 5%			
Varieties			± 0.38		1.067			
Period			± 0.32		0.90			
Variety × period			± 0.85		2.38			
C. V. %				6.87				

Figures in the parantheses indicate retransformed values

Popular seven varieties viz. Gola, Seo, Seb, Mundia, Umran, Chameli and Local were kept under observation to find out their susceptibility to fruit-fly infestation. Five trees of each variety having uniform growth were choosen and hundred fruits were observed at the time of each picking. In all five pickings were taken during the season to record the infestation of ber fruit- fly, *C. vesuviana*. The observed damage was converted to percentage incidence. The percentage incidence was transformed to angular values and the data were analysed following the procedure of complete randomised design.

The mean per cent infestation of fruit-fly in 7 varieties are given in Table 1. The statistical analysis revealed that there is a significant difference in fruit-fly incidence due to variety, period and variety × period. This shows that there is a significant difference in preference of different ber varieties by ber fruit-fly. The results also indicated that the local variety was least preferred by fruit-fly followed by Mundia, Seo, Seb, Umran, Chameli and Gola having 15.01, 17.14, 21.89, 22.47, 31.96 and 32.89 per cent damage respectively. Chameli and Gola were the most susceptible varieties and remained at par in fruit-fly infestation. Seb and Umran varieties were medium in fruit-fly infestation and remained on par with each other. It was also observed that highest infestation of fruit-fly (31.80%) was observed in the first picking made in third week of January. The present findings are in agreement with the results obtained by Singh and Vashishtha[7] in Rajasthan. They found that local variety was least attacked by fruit-fly followed by Mundia. The same results are also reported by Mann and Bindra[8], Butani[9], Anonymous[10] and Pareek[3]. The least preference of ber fruit-fly to local variety might be owing to hardness of pulp and less sugar content. Hence this variety can be incorporated in breeding programmes for evolving resistant varieties of ber orchards.

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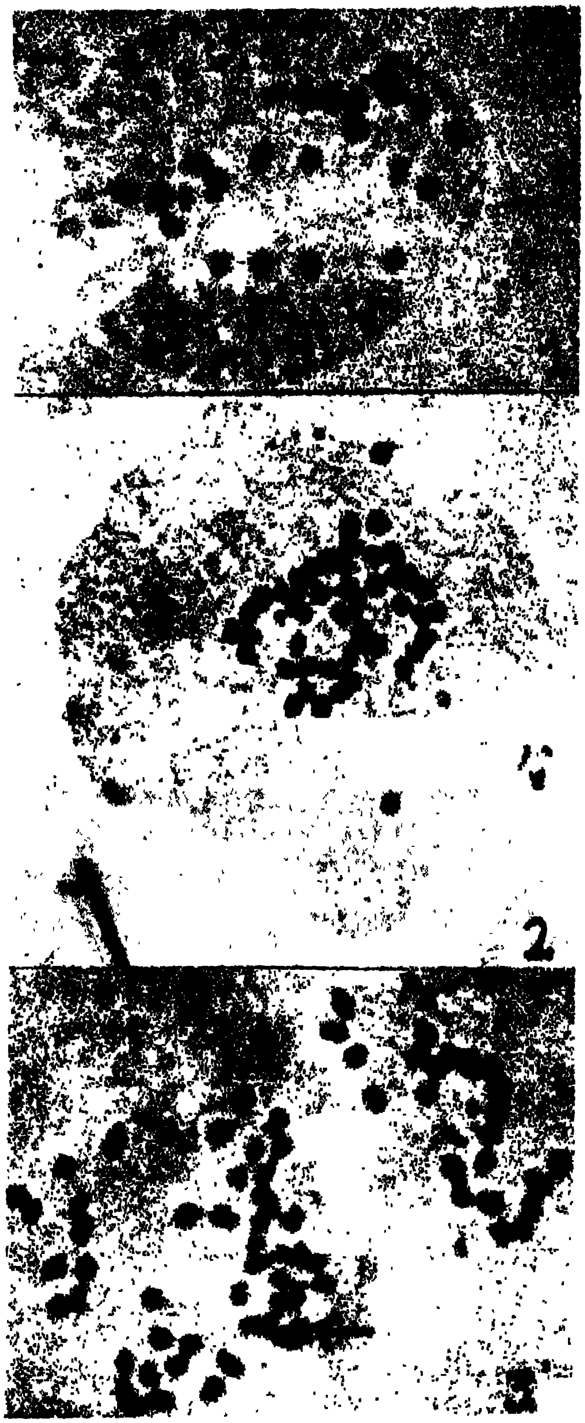
Solanum nigrum complex : Effect of temperature

Temperature constitutes an important component of natural environment and the ability of plants to withstand the extremes of it is interesting to note. High-temperature treatment was found to induce univalents in pollen-mother cells (pmc) of wheat[1]. A number of authors have followed the fate of temperature-induced univalents in the various steps of meiotic sequences[2, 3]. In the present investigation, *Solanum nigrum* has been examined from this point of view.

Natural temperature was unusually high in the month of May-June of 1987 when this ranged from 25-30°C in early morning and 40-46°C during day. All members of the *S. nigrum* complex grow well in winter (18-25°C). To study the effect of temperature, flower buds were fixed in 1 : 3 acetic-alcohol during day time. Pollen fertility was determined on the basis of their stainability in 1% acetocarmine solution. Empty and unstained pollen-grains were classified as sterile, and spherical, filled and stained ones as fertile. Maximum number of univalents were scored where



Figs. 1-3: (1) Metaphase I showing 22I + 1II in diploid; (2) Metaphase I showing 48I in tetraploid; (3) Metaphase I showing 70I + 1II in hexaploid .(All × 2000)

they are easily distinguished from the bivalents under unpaired condition, and also by their failure, in most cases, to assemble on the metaphase plate. The number of univalents per pmc was more in tetraploid *S. villosum* and diploid *S. americanum* than hexaploid *S. nigrum* (Figs. 1, 2 and 3). It is assumed that high temperature could have prevented synopsis. The other abnormalities in the complex included clumping of chromosomes at metaphase I, high frequency of laggards and organization of micronuclei.

The pollen sterility in the complex was variable in response to temperature. It was high in diploid and tetraploid plants (45 and 60%, respectively) but less (28%) in hexaploid, while in normal condition pollen sterility were 5, 9 and 8% in 2×, 4× and 6× forms, respectively. The diploid and tetraploid forms being recently introduced under the present climate have shown higher pollen sterility than the more ancient hexaploid form which is better stabilized under the present conditions. The increased level of ploidy is generally found associated with greater physiological plasticity. The pollen sterility encountered in the present complex was proportional to the formation of univalents. Temperature appeared to have lowered seed-setting also, showing 30, 12 and 35 seeds per fruit while under normal condition 61, 21 and 50 seeds were recorded in diploid, tetraploid and hexaploid, respectively. Thus, the observations are indicative of tetraploid *S. villosum* very sensitive to temperature.

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Seed variations in *Tephrosia purpurea* Pers. of Indian desert

Tephrosia, a sub-tropical genus, is widely distributed throughout India. It is a characteristic species of semi-arid and arid lands of the world. *T. purpurea* is found in different edaphic conditions ranging from cultivated fields and gravely belts to sand dunes and sandy plains of Indian desert. Polymorphic forms in the populations of *T. purpurea* growing at Waltair have been recognised[1]. In Indian desert, the earlier studies revealed that the flower colour ranges from crimson-red, red, pink, light pink, pinkish-white and pure white[2]. However, no work has been done on the variations in the seed characters of this species showing a large ecological amplitude.

For the present study, the populations of *T. purpurea* at Osian (sand dunes) and Pal (sandy plain) two sites of Jodhpur district were screened (200-300 plants) in 1986-87 (Aug - Sep). The various characters, *viz.* seed weight, pod-length, seed output/ plant, plant height were measured from each individual plant. Based on distinct seed-coat patterns, plants were categorised into six clusters. The percentage of occurrence of each cluster was calculated; in each cluster, the average has been set (Table 1). All data were statistically analysed[3].

Characteristics of seeds, more than any other characters require precise integration and coordination between different functions, for successful reproduction to occur especially in arid zones. Moreover, the adaptive values of seed size, shape, and output as well as food storage in the seed may conflict with each other to such an extent that reproductive efficiency in a particular habitat may represent a compromise among the conflicting demands. A perusal of Table 1 reveals that yellow colour is dominant in general. However, seed colour ranges from shades of yellow to brown and are in cylindrical shape. The weight of seeds and length of pods collected from sand dunes were comparatively greater than those of sandy plains. The seed output is comparatively higher in populations of sandy plain. However, the variations are not significant when statistically analysed.

TABLE 1 : Seed morphological characters of *T. purpurea*, at two different habitats in Indian desert

Colour pattern	% of occurrence	100-seed weight (mg)	Length of pod (cm)	No. of seeds/pod	Seed output/plant	Height of plant (cm)
Pal :						
Yellowish brown	4	1310.49	4.24	6.67	222.67	38.33
Dark brown	8	1236.66	3.69	6.00	279.88	45.17
Yellow	10	1369.65	3.65	5.90	256.90	49.20
Light brown	13	1382.29	4.03	5.94	247.00	40.85
Greenish yellow	21	1235.47	3.75	6.25	259.13	47.75
Light yellow	44	1244.41	3.81	6.15	245.68	37.38
Computed F value		2.62*	1.87^{ns}	1.392^{ns}	1.088^{ns}	6.45**
CD at 5%		115.65	—	—	—	1.76
Osian :						
Yellowish brown	6	4176.26	4.67	4.00	199.25	44.25
Dark brown	10	4088.79	4.55	3.78	160.63	47.00
Light brown	10	3987.42	4.48	4.28	212.29	43.43
Greenish yellow	15	4465.53	4.58	3.98	147.62	45.36
Yellow	19	4038.66	4.66	3.84	157.86	42.73
Light yellow	40	4200.59	4.66	3.81	157.33	50.56
Computed F value		1.35^{ns}	0.491^{ns}	0.34^{ns}	1.635^{ns}	1.54^{ns}
CD at 5%		—	—	—	—	—

ns = Non- significant * = Significant at 5% level ** = Significant at 1% level.

Except the report of bizarre seed patterns of 45 Indian species[4], nothing is available on seed morphology of desert plants. The present investigation gives a glimpse of the bizarre seed patterns of desert plants. Probably desert is the only habitat where seed is subjected to rigorus environmental conditions and thus the identification of isolated seeds is more difficult due to the variations. Morphological characters not only vary between species, but to a great extent, variations also occur within a given species. A comparison of morphological characters in a group of related species having different ecological requirements should provide useful information on the adaptive basis of their differentiation. The discovery of seed-morphological variations is noteworthy and its cytological study might reveal interesting results in their populations.

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Effect of sodium fluoride on adrenal and hypothalamus in weaver bird

Noticeable changes in the hypothalamo-neurosecretory system were recorded in Guinea pig with the administration of sodium fluoride[1]. The salt treatment induced depletion of neurosecretory material both from supraoptic (SON) and paraventricular (PVN) nuclei in spotted owlet[2]. The present problem is undertaken with a view to find out the effect of sodium fluoride on hypothalamus and on adrenal function during the breeding season of an avian representative.

TABLE 1 : Gravimetry and cytometry (Mean value ± standard error) of adrenal and hypothalamic neurosecretory nuclei in weaver bird after sodium fluoride treatment

Sex	Treatment	B. Wt. (g)	Adr. Wt. (mg)	Cortical cord width (µm) SCZ*	Cortical cord width (µm) CZ	Nuclear diameter (µm)	Nuclear diameter (µm) M	Nuclear diameter (µm) SON	Nuclear diameter (µm) PVN
Male	Control (10)**	30.40 ± 3.41	3.60 ± 1.21	42.81 ± 2.51	38.51 ± 1 63	4.53 ± 0.73	5.30 ± 0.62	9.25 ± 0.71	9.15 ± 0.63
	Treated (15)	30.10 ± 2.53	4.00 ± 1.53	51.32 ± 1.39*	45 60 ± 1.29*	6.53 ± 0.91*	4.75 ± 0.86	7 75 ± 0.88	7.52 ± 0.49
Female	Control (10)	30.00 ± 2 73	3 40 ± 1.19	45 06 ± 2.32	39.30 ± 2.00	4.75 ± 0.82	5.45 ± 0.69	9.30 ± 0.45	9.27 ± 0.51
	Treated (15)	29.00 ± 2.51	4.00 ± 1.76	56.00 ± 2 12*	49.15 ± 2.11*	7.00 ± 0.75*	5.05 ± 0.81	7.50 ± 0.61	7.15 ± 0.44

*SCZ = Subcapsular zone; CZ = Central zone; C = Cortex; M = Medulla; SON = Supraoptic nucleus; PVN = Paraventricular nucleus

** Number in parenthesis are used birds

A total of fifty adult weaver birds (*Ploceus philippinus*) of both sexes during their breeding season was divided into four groups. Each sex consisting of 25 birds of which 15 birds were used for treatment and remaining 10 served as control. Intramuscular treatments were conducted either with sodium fluoride at a dose level of 5 gm/100 g body weight or with distilled water. All the birds were sacrificed by cervical dislocation after one hour of the treatment.

The hypothalamo-hypophysial complex and the adrenals were dissected out. Tissue sections of Bouin's fixed hypothalamo-hypophysial complex were stained with aldehyde fuchsin[3]. After taking the adrenals weight, one of them was fixed in Bouin's fluid for histological sections stained with haematoxylin and eosin. The other one was macerated in appropriate solutions for the estimation of cholesterol[4], Ascorbic acid[5] and catecholamines[6].

In both sexes the adrenal cortical cord width (subcapsular and central zones) was elevated after sodium fluoride treatment (Table 1). The cortical nuclear diameter was increased significantly (P <0.05). In treated birds distorted medullary region showed vacuolation. Nucleolus was conspicuous both in cortex and medulla. The diameter of hypothalamic nuclei (SON and PVN) decreased after the salt treatment (Table 1). Polar accumulation of neurosecretory material in both nuclei decreased in treated birds.

Cholesterol and ascorbic acid concentration in adrenal tissues of both sexes increased significantly (P <0.001) after the treatment. The salt administration caused significant reduction of catecholamines in adrenal tissue (Table 2).

TABLE 2 : Biochemical changes in the adrenal gland of weaver bird after sodium fluoride treatment (Mean value ± standard error of five samples) expressed in µg/mg of tissue

Sex	Treatment	Cholesterol	Ascorbic acid	Epinephrine	Norepinephrine
Male	Control	39.35±3.62	0.81±0.05	0.83± 0.04	1.03±0.03
	Treated	80.00±4.93*	2.30±0.04*	0.27±0.05*	0.17±0.04*
Female	Control	37.31±3.90	0.82±0.04	0.82±0.04	1.39±0.04
	Treated	86.71±4.27*	2.12±0.05*	0.25±0.03*	0.15±0.05*

* P<0.001

The adrenocortical hypertrophy with the significant elevation of biochemical parameters cholesterol and ascorbic acid in the adrenal tissue suggest the inhibition of corticoidogenesis by sodium fluoride treatment.

The fluorosis resulted for the depletion of neurosecretory material (NSM) in hypothalamic cell nuclei of weaver birds suggests that the augmented synthesis of ACTH causing hypertrophy in adrenal tissue. The sodium fluoride salt probably blocking oxidation resulting inhibition of corticoidogenesis from cholesterol and catecholamines from dopamine.

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Problem of cell contact and fusion

Adhesion between adjoining cells is a fundamental biological event, preceding both morphogenesis and organogenesis and also providing the basis for cellular recognition and membrane fusion[1]. The fusion of two cells initially involves contact and specific adhesion of the surface structures[2].

Various forces in cellular interaction can take place[3]. The DLVO (Derjaguin - Landau - Verwey - Overbeek) theory indicates that the interaction engery of biological membranes at fixed separation is mainly due to attractive and repulsive forces; in general, electrostatic forces tend to keep the membranes apart while attractive forces, largely as London-van der Waals forces, tend to favour contact between the membranes. Since these forces act over considerable distances (up to several hundred angströms), they could explain the mutual attraction of cells, their adhesion at a constant separation and the persistence of a force resisting separation of the cells. The close approximation of cell surfaces prior to fusion could only be achieved if the approach and contact between them was made by microvilli with a low radius of curvature[4] (<0.1 µm). Microvilli of these dimensions are able to overcome the potential energy barrier opposing close contact between the surfaces. Once close contact has been achieved between membranes, the events responsible for fusion can take place. For membrane fusion, the displacement of Ca^{2+} from the membrane is required to provide ionic sites for molecular interaction with other membranes.

The potential energy of repulsion, W_R (which prevents contact) between two similar particles of radius a can be written as[5]

$$W_R \quad \frac{\epsilon a^2}{R} \phi_0^2 e^{-\kappa s} \qquad (1)$$

where s is the shortest distance between surfaces, then the distance between centres is $R = 2a+s$, ϵ is the dielectric constant of the medium, ϕ_0 is the electrostatic surface potential which is related to the zeta potential (ζ),

$$\kappa^2 = \frac{8\pi n e^2 v^2}{\epsilon kT} \text{ cm}^- \qquad (2)$$

n is the number of ions of each species per unit volume of solution, e the charge and v the valency, $\lambda = 1/\kappa$ ($\alpha C^{-1/2}$) is the Debye- Hückel screening distance, C is the concentration which is usually expressed in moles per liter of solution.

The zeta potential can be computed from the electrophoretic mobility. If u represents the cellular electrophoretic mobility (cm/s per volt/cm), the zeta or electrokinetic potential is given by[6]

$$\zeta = \frac{4\pi\eta u}{\epsilon}, \qquad (3)$$

η is the dynamic viscosity of the suspending fluid at the shear plane. The magnitude of ζ is considered a measure of the cell-cell repulsion. At a critical value of the zeta potential, the cellular repulsion will no longer be strong enough to prevent contact. The seat of the zeta potential is the shearing plane between the bulk fluid and an envelope of fluid which moves with the cell.

The interacting regions of two cell peripheries must come to within about 4 Å of each other when they make contact[7]. For R<<2a, one can write

$$W_R = \frac{\epsilon a\zeta^2}{2} e^{-\kappa s} \qquad (1a)$$

The potential energy of attraction W_A between two spheres is

$$W_A = -\frac{A}{12} \cdot \frac{a}{s} \qquad (4)$$

s <<2a, A is known as the Hamaker constant.
When R>>2a,

$$W_A \simeq -\frac{16\,A}{9} \cdot \frac{}{s^6} \qquad (5)$$

In the case of a sphere approaching a flat plate, which may be more relevant to a cell process with a hemispherical end approaching a noncellular surface, the net repulsive barrier W is given by

$$W = -\frac{A}{12}\,\frac{a}{s} + 16\epsilon a\left(\frac{kT}{e}\right)^2 \gamma^2 \exp(-\kappa s) \qquad (6)$$

Where $\gamma = (e^{z/2} - 1)/(e^{z/2} + 1)$, $z = \phi_0 e/kT$,

k is Boltzmann's constant and T the absolute temperature.

Equations (1) and (6) show that cell contact is expected to be promoted by low-surface potential ϕ_0 by low radius of curvature of contacting cell surfaces, by low environmental dielectric constant ϵ and by factors reducing the effective thickness of the electrical double layer of ions associated with the cell surface ($1/\kappa$). Equation (2) shows that $1/\kappa$ may be reduced by raising environmental ionic strength and/or valency. The factors may be significantly altered by the action of enzymes due to division or growth. Under physiological conditions, the presence of calcium and magnesium ions will reduce the thickness of the electrical double layer, and hence the magnitude of the repulsive force between the cells[3].

For small distances, the net interaction energy as a function of cellular separation is given by

$$W = W_A + W_R, \qquad (7)$$

Where W_A and W_R are defined in equations (4), (5) and (1a).

The total potential energy is related to the zeta potential. If ζ is large, W_R (which is proportional to ζ^2) becomes larger. Since the total interaction energy is the sum of W_R and W_A, one can make ζ so large that a maximum will appear in W with s. At large distances W is attractive (i.e. van der Waals' attraction is important), because W_A is proportional to $1/s^6$ (equation 5), whereas W_R decreases exponentially. As the separation distance becomes smaller, the electrical repulsion takes over and finally van der Waals attraction becomes more prominent again. The maximum of W with s signifies an activation energy. Cells will not come in contact, if they are unable to overcome this activation energy which is directly related to s. The transitional case for cell contact can be obtained from the conditions W = 0 and $\frac{dW}{ds} = 0$ for the same value of s, which will give $\kappa s = 1$ and thus

$$= \frac{2.207\epsilon\zeta^2}{A} \qquad (8)$$

This with the help of equation (2) gives $\zeta_{contact} = 23$mv, when $\lambda = 100$Å, $A = 10^{-12}$ erg, $\epsilon = 80$. With a much lower van der Waals constant ($\approx 10^{-14}$ erg), as proposed by Pethica[8], one will find $\zeta_{contact} = 2.3$ mv.

The reduction in radius of curvature would facilitate very close approach of cells "through" the total potential energy of interaction barrier[7]. Surface charge has been shown to be related to cell contact behaviour[9]. In the biological problems, ζ has a negative value which further depends on the pH values. (Typical intracellular pH values are[10] 6.8-7.0 in animals. The pH of the extracellular fluid is greater than inside the cell). Cancer cells have lowered potentials[11]. These changes reflect alterations in ionic balances across the membranes and are a result of intracellular alterations. This could account for their changed permeability and mobility. When the electrophoretic mobility of clonal lines of normal and tumour cells are measured, the polyoma transformed cells are found to be more electronegative[9].

Cell-to-cell interactions are modified by surface changes promoting or inhibiting cell proliferation into tumour masses. Changes in cell membrane are responsible for malignant growth[12]. Anchorage-independence has been found to be one of the most consistant correlates of tumorogeneicity *in-vivo*[13]. The change from normal to tumour cell is accompanied by an increased surface charge. Blood cells which have a high negative surface charge are comparatively non-adhesive[3]. For fusion to occur, a relatively high proportion of the lipids of both membranes may need to be organised in micelles of lipid or lipoprotein[14]. Interdigestion of the micelles of the two membranes could then lead to membrane fusion. The probability of fusion, however, varies from cell to cell[15]. Fusion between malignant and normal human cells results in the suppression of malignancy as measured by tumour formation[16]. Malignant-malignant hybrids retain their malignant character.

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Effect of some broad-spectrum antibiotics on the survival of maggots and adult emergence of melon fruit fly, *Dacus* (Chaetodacus) *Cucurbitae* Coq. (Diptera : Tephritidae)

Insects are quite unique in having symbiotic relationship with bacteria, fungi, yeast and even protozoa. The presence of bacterium symbiotes have already been reported in the peritrophic membrane of the maggots of *Dacus oleae* for their normal growth and development[1]. Information on the symbiotic relationship in melon fruit fly is limited. Hence, the present investigation was carried out to find out the effects of two antibiotics, viz. streptocycline and sulphanilamide on the survival of maggots and adult emergence by injecting the various dosages, i.e. 50, 200 and 500 ppm in the cucumber fruits.

Cucumber (*Cucumis sativus* L. cv. Japanese Long Green) was sown in 25 plastic pots on April 5, 1986. All the pots were tranferred to the screen house after the germination of seeds and finally only one plant per pot was maintained for fruiting. The culture of the *D. cucurbitae* was maintained in the laboratory on the tender fruits of cucumber kept in ten glass aquarial (30 × 20 cm) for getting the newly hatched (1-2 hr old) maggots. Cotton pieces soaked in liquid food (10% sugar + 2% yeast in water) were kept in petri-dishes in each aquarium for the feeding of adults and the food was changed twice in a day. Those fruits, having resinous deposit (egg-laying spots) on the surface, were sorted out for newly hatched maggots. Fruits, having eggs inside, were examined twice a day in a binocular for the collection of maggots.

The experiment was planned in a randomized block design with 7 treatments and 3 replications. Streptocycline and sulphanilamide in 3 different dosages, viz. 50, 200 and 500 ppm were injected in the tender (50-60 gm) and healthy fruit of cucumber with an untreated control experiment where only the solvent, i.e. distilled and sterilized water was injected. An alcohol sterilized micro-syringe was used for the injection of antibiotic solutions (1 ml/ fruit). Twenty-one fruited plants already grown in the screen house were selected and only one tender fruit/ plant was left for the injection and release of maggots and thus single fruit represented one replication. Ten newly hatched (1-2 hr old) maggots per fruit (replication) were released just below the fruit skin (3-4 mm deep) by making 'V' shape cut on the surface with the help of an alcohol sterilized stainless steel knife. The cut signs were sealed with a non-phytotoxic antimicrobial glue to prevent the entry of microbes from out side. On 7th day, all the fruits having maggots inside were examined for counting the mortality (maximum larval period in the month of June was 6 days). Per cent survival of the maggots was worked out in each replication. Live maggots from each replication were transferred in glass jars (20× 15 cm) separately filled with sterilized sandy loam soil for pupation and then the jars were covered with muslin cloth to prevent the entry of pupal parasitoids. The number of adults emerged in each replication were counted up to 10 days and percentage emergence was worked out. The pupae which did not emerge and those adults with any type of abnormality in shape were considered as dead. Per cent rotting in the pulp in each fruit (treated and untreated both) was worked out on weight basis. All the per cent data were transformed into their angular values[2] and then analyzed statistically.

A perusal of Table 1 reveals that the % survival of maggots and adult emergence varied according to dose of antibiotics injected in the fruits. Streptocycline and sulphanilamide in higher dose (500 ppm) showed marked lethal action on the maggots (23.33% and 33.33% survivals, respectively) as well as on adult emergence (41.65% and 44.45% emergence, respectively). The reasons for this might be due to adverse effects of these antibiotics on the bacterium symbiotes which are beneficial for their normal growth and development in the immature stages. In the lower dosages (50 and 200 ppm) of these two antibiotics, % survival of maggots as well as % adult emergence were considerably higher and statistically at par with the control experiment which might be due to enzymatic degradation of these antibiotics by the symbiotes or in lower dosages these antibiotics did not prove lethal for the symbiotes. In the higher dose (500 ppm) of streptocycline and sulphanilamide, % rotting in the pulp was considerably very low, i.e. 11.73% and 12.93%, respectively which might be due to lethal effects of these antibiotics on the bacterium symbiotes. These symbiotes have already been reported to be responsible for rotting in the pulp of damaged fruits by the maggots[3]. In the lower dosages (50 and 200 ppm) of these two antibiotics, % rotting in the pulp was considerably high (71.80 to 75.46% W/W) which was found statistically at par with % rotting recorded in control experiment (76.10%). The

TABLE 1: Effect of streptocycline and sulphanilamide on the survival of maggots and adult emergence of *D. cucurbitae* Coq. damaging cucumber, *Cucumis sativus* L. (Summer season, 1986)

Treatment	Dose injected (ppm)	No. of newly hatched maggots released	Mean % survival of maggots		Mean % adult emergence		Mean % rotting in pulp (W/W)	
			Original value	Transformed value	Original value	Transformed value	Original value	Transformed value
Streptocycline	50	30	80.00	63.93	80.09	63.73	72.76	58.55
Streptocycline	200	30	76.66	61.21	82.73	65.69	71.80	57.92
Streptocycline	500	30	23.33	28.85	41.65	40.00	11.73	20.01
Sulphanilamide	50	30	86.66	68.85	80.00	63.73	75.46	60.31
Sulphanilamide	200	30	80.00	63.93	86.30	68.28	73.30	58.89
Sulphanilamide	500	30	33.33	35.21	44.45	41.74	12.93	21.05
Untreated Control*	—	30	86.70	68.89	86.90	68.79	76.10	60.72
SE (m)				4.646		4.315		1.980
C. D. 5%				10.123		9.402		4.314

* Only distilled and sterilized water.

reasons for this might be that these two antibiotics in lower dosages could not kill the symbiotes.

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Effect of certain nucleic-acid antimetabolites on the seed germination of *Pistia stratiotes* L.

Seeds of *Pistia stratiotes*, an aquatic angiosperm, are positively photoblastic and burial or darkness *per se* restircts their germination[1]. Such being the situation, an investigation was carried out to adjudicate the effects of certain nucleic-acid antimetabolites (which inhibit protein synthesis) upon the dark germination of seeds of this species. Black and Richardson[2-3] examined the influences of a number of inhibitors of RNA and protein synthesis on light-induced germination of lettuce seeds and found some of them to stimulate germination in darkness. Information concerning the impact of these substances on hydrophytes is minimal and none is availabel for *Pistia*. Thus, this study was designed to examine the relative effectiveness of antimetabolites such as pyrimidine (uracil and thiouracil) and purine (adenine and xanthine) bases in regulating the seed germination of *P. stratiotes*.

Seeds of *Pistia stratiotes* were collected in February 1975 and stored at room temperature in a dry place until use. Tests of germinability (20 mature seeds per treatment) were made in a glass Petri-dish (9 cm diameter) on a single disc of filter paper (Whatman No. 1) wetted with 4 ml of the test solution or water. the emergence of operculum (which is equivalent to radicle) was selected as the criterion of germination. After soaking for 10 days in various solutions, the unsprouted seeds were transferred to water in Petri-dishes and were held for additional 10 days. Both before and after transfer, the dishes were placed in the dark chamber of an incubator at 25 ± 1°C. All the results are the means of at least two separate experiments, each with four replicates.

TABLE 1 : **Effects of pyrimidine and purine bases on the dark germination of *P. stratiotes* seeds**

Substance	Germination (%) Before transfer to water	Germination (%) After transfer to water
H_2O	0	30.0
10^{-2}M Uracil	0	30.0
10^{-3} M Uracil	0	25.0
10^{-4} M Uracil	0	30.0
10^{-5} M Uracil	0	15.0
10^{-2} M Thiouracil	0	0
10^{-3}M Thiouracil	0	0
10^{-4} M Thiouracil	0	17.5
10^{-5} M Thiouracil	0	5.0
10^{-2} M Adenine	0	0
10^{-3} M Adenine	0	0
10^{-4} M Adenine	35.0	65.0
10^{-5} M Adenine	62.5	90.0
10^{-2} M Xanthine	12.5	90.0
10^{-3} M Xanthine	70.0	70.0
10^{-4} M Xanthine	60.0	82.5
10^{-5} M Xanthine	65.0	82.5

TABLE 2 : **Effects of interaction of two purines (adenine and xanthine) and a single pyrimidine (thiouracil) on the dark germination of *P. stratiotes***

Pre-treatment	Duration (hr)	Concentration of thiouracil (M)				
		0	10^{-2}	10^{-3}	10^{-4}	10^{-5}
10^{-5}M adenine	24	0	0	0	0	0
	48	5.0	0	0	2.5	2.5
	96	20.0	0	0	37.5	45.0
10^{-2} M xanthine	24	5.0	0	0	5.0	7.5
	48	30.0	0	0	37.5	45.0
	96	32.5	0	0	10.0	37.5

It appears from the present study that pyrimidines such as uracil and thiouracil act as in hibitors to the seed germination of *P. stratiotes*. This is due to the fact that both the compounds have similar molecular structure[4]. However, purines behave differently. In the case of adenine, 10^{-2} and 10^{-3} M solutions exert strong inhibitory action and 10^{-4} and 10^{-5} M solutions induce a promotive effect. At all levels of supply, the xanthine solution shows stimulation.

The interaction of thiouracil with adenine or xanthine is followed for *P. stratiotes* germination. While thiouracil causes inhibition, the latter can be overcome if adenine pre-treated seeds are sown in a medium containing the first compound. This is unlike the findings of Shimeno and Kinoshita[5] who were unable to get a relieving effect by the use of mustard seeds. In our work, the relieving effect is secured with 96-hr adenine pre-treatment and not with the 24-hr or 48-hr pre-treatment. However, such a relieving effect can be had only with 48-hr xanthine pre-treatment and not with the pre-treatment of shorter or longer duration of this compound. It would be interesting to find out whether the inhibitory activity of uracil can be offset with the application of these two purine bases or with various analogues. How these substances do stimulate germination of light-requiring seeds in darkness is under investigation in this laboratory.

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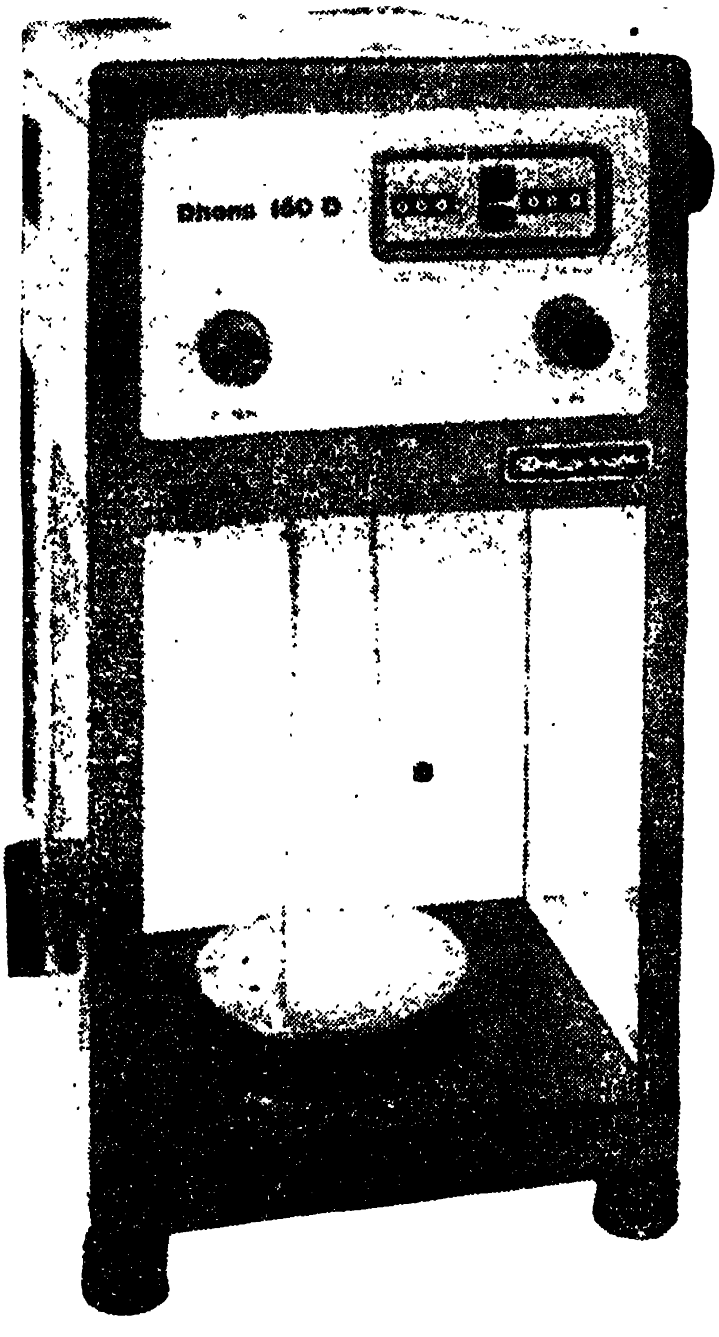

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SCIENCE
& CULTURE C. V. Raman Centenary Supplement

PROF. C. V. RAMAN—A TRIBUTE

THE country celebrated the birth centenary of Sir C. V. Raman, who distinguished himself in the world community of scientists by winning a Nobel prize for physics in 1930. It was a wise decision to have one celebration, collaborated by all the different organisations, to pay our tribute to the great scientist. Thus except for token meetings at different institutions where Raman had worked, the attention was concentrated on the function preceded by an international conference at Calcutta in the Indian Association for the Cultivation of Science. However, several journals and periodicals brought out special issues in this birth centenary month and many were the books which came out on the life and works of Professor Raman. Hence *Science and Culture* decided to bring out a special issue on the life and work of Professor Raman.

Professor Raman left Calcutta in 1933 after nearly three decades of his stay and work in the city and the Indian Science News Association was born only later. Consequently we hardly find any of his articles in the pages of *Science & Culture*, the journal of the Association. However, there is reference to his work by other workers in the field. In 1971, after his death, a large number of pages were devoted to his memory (some of those tributes are reproduced in this issue).

It is rather unfortunate that Raman's departure from Calcutta was sudden and was not on a very happy note. He wanted to keep contact with the Institute which nurtured his ideas and offered opportunity to do the work of break-through importance, but the circumstances forced him into isolation and start afresh at Bangalore. He did establish himself in a respectable way and fostered an Institute which has again gained the worldwide acclaim as an Institute of excellence.

Raman had his peculiarities and distinguishing characteristics. Long hours of lonely contemplation and intense dedicated work had left some distinct marks in his mannerisms. The present author had the opportunity of meeting him and spending a good length of time in his company in 1958 after the Science Congress Session at Madras.

Those were the early days of my research career when I had hardly published two papers and presented a couple others at conferences. Thus there was great enthusiasm to go to Bangalore and visit important research institutes. Along with a couple of fellow research students we visited the Indian Institute of Science, its physics department and especially the high voltage engineering section. Raman Institute being close-by we thought of visiting it too. Some of our local friends told us that Professor Raman does not allow anyone to come near the Institute, leave alone visiting it. In his advanced age he was a bit unpredictable, secondly we were coming from the Institute of Nuclear Physics whose director was Professor Meghnad Saha, with whom Raman did not have good relations. Hence we were going in for the wrath of Professor Raman. This discouragement diffused the enthusiasm of two of my colleagues and I had to go with one only. We gathered our courage and at around eleven entered the unguarded gate of the Raman Institute. When we reached the steps of the main building a darwan enquired what did we want. We expressed our desire to visit the laboratories. The darwan informed that at that moment there was no one there and only Professor Raman could permit the visit and Professor Raman was expected at 2 00 p.m. We could go there at that time and try our luck. Triumphant at our first attempt we had a hurried lunch and returned back to the Institute before time.

Professor Raman arrived promptly at 2 00 p.m. and when he saw us waiting on the steps enquired from where we came. When we replied that we were from Calcutta and the Institute of Nuclear Physics and expressed our desire to see his Institute, he jovially said that "you were coming from a big Institute where modern things were done. Ours is a small Institute and we do classical things. How will you be interested in our work ?" After a pause, he continued that we had come from a long distance and we must see his Institute. Then he remembered that there were no assistants to show us round and volunteered to show us round as he did not have any thing very important to attend to. It was a unique experience to move around with the great scientist continuously talking without any hesitation inspite of the fact that there was great difference in age and we were total strangers. He told us about all his research assistants, some of their personal problems too and the type of work they were doing. He particularly pointed out the salient features of the apparatus and all along made us feel at ease. After about an hour's tour, the darwan came in to inform that there was a phone call from some one for the Professor. At that stage the Professor took leave from us (we were in the museum) where he was explaining the history of each exhibit in the most absorbing manner. It was like a pleasant dream broken and his parting words were—not to leave the Institute without seeing the dark room.

In fact, Professor Raman was proud of his dark room which had no doors. Any one could walk in at any time without disturbing any development work going on there. The path was such that the rectilinear propagation of light could not reach the sanctum by any means of scattering. The design was one to be proud of.

We came out highly impressed in the kind treatment of Professor Raman. Today when I read some of the write-ups about Professor Raman (especially published in the centenary year) I wonder whether Professor Raman harboured any ill-feelings against anyone. His child like simplicity in meeting strangers and making them feel at ease was of a remarkable quality. This simplicity marked his approach to any problem whether in science or in daily life. I was told that sometimes in 1970 a few months before his death, he had been to Kanpur and he had difficulty in finding accommodation. Though Kanpur was a big industrial city it was lacking in good hotels and easy accommodation. He thought over the problem and arrived at a conclusion that Kanpur was not having hotels because it was not having enough historical ruins to attract tourists as in Delhi, Agra and other places. To the delight of his audience at National Physical Laboratory, he narrated this thought process in a lighter vein.

Professor Raman was a great scientist but very much human with many weaknesses which he utilised to the best advantage. Here in this collection of articles by several noted persons these characteristics are high lighted. This is our tribute to his genius as well as his humane nature. □

B. B. Baliga

SIR CHANDRASEKHARA VENKATA RAMAN

J. C. GHOSH

VENKATA RAMAN was born on November 7, 1888, at the town of Trichinopoly, which stands at the head of the Cauvery delta and which, with its picturesque rock crowned by a temple, is famous in South Indian history. His ancestors on the paternal side were Brahman landholders, owning and farming agricultural property in a small way at a village near Ayyampet in the district of Tanjore. The father, R. Chandrasekhara Iyer, was the first in the line to break away from the village and the traditional occupation and to seek the path of Western learning. At the time his second son Venkata Raman was born, Chandrasekhara Iyer was a pupil teacher in a local high school, studying for his bachelor's degree. The mother, Parvathi Ammal, was a scion of a Trichinopoly family of "Sastris" or Sanskrit Pandits ; her father, it is said, had as a youth walked all the way from Trichinopoly to Nadia in Bengal to study "Nyaya" or law and had returned to his native town to practise in the local courts. In this ancestry on both sides we can trace the origin of the vigour of mind and of the adventurous and independent spirit coupled with a love of learning which characterise the subject of this biography. Soon after Venkata Raman was born, his father took his bachelor's degree in physical science and secured a position as a teacher in one of the local colleges. He was also deeply interested in South Indian music and learned to play it on the violin. It is not surprising therefore that, at a very early age, Chadrasekhara Iyer's children acquired a love of music, and that the mind of Venkata Raman turned naturally to the study of science.

Not content with a position of which the emoluments were insufficient to meet the needs of his growing family, Chandrasekhara Iyer decided early in 1892 to quit the Tamil country and seek his fortunes in the land of the Andhras. His friend, Mr. P. T. Sreenivasa Iyengar, who had preceded him and held the position of Principal of the Hindu College at Vizagapatam invited him to become Lecturer in Physics at the same College. The offer was accepted and Chandrasekhara Iyer moved with his family to Vizagapatam after making what was then a long and arduous journey. Here, in lonely houses on the seashore at Waltair, Chandrasekhara Iyer and Sreenivasa Iyengar lived near each other and worked, and here Venkata Raman grew up amidst scenes of picturesque natural beauty and in an atmosphere of scholarly life and endeavour.

Sreenivasa Iyengar was a brilliant scholar and teacher who took the English classes at the College, while Chandrasekhara Iyer taught physics and mathematics. The environment was thus favourable for the speedy recognition of young Venkata Raman's abilities and the provision of special facilities for its encouragement. At a very early age he acquired a remarkable mastery of the English language and developed an enthusiasm for scientific studies which was so all-absorbing as to leave no inclination for the study of less favoured subjects. While in the high school classes, Venkata Raman had learnt all the physics that could be found in such treatises as Ganot's *Physics*, and was eager for more. The strain of less congenial but nevertheless compulsory studies, however, told on his health, and the foetid atmosphere of the town into which the family had meanwhile moved brought on serious illness. The young lad survived with some difficulty to pass the marticulation examination at the age of twelve. Two years later he passed the First Arts Examination of the University, securing a high position in the list in spite of the fact that physics did not figure amongst the subjects for study.

The scene then shifts to the Presidency College at Madras where the young lad enrolled as a University student. He soon attracted the attention of the professors, who were astonished by the maturity of knowledge shown by one who was scarcely old enough to be a student in the degree classes. A useful result of this impression was that the routine of lectures and practical classes was partly set aside in his favour, thus allowing more freedom for his chosen studies. The latter included especially mathematics and mechanics, thus laying the foundation for later excursions into theoretical physics. At the degree examination of 1904 he was the sole first class of his year in science and was awarded the University Gold Medal for physics, besides receiving the college prizes for English essay writing. For the next two years he was a student working for his M.A. degree, very happy at having no lectures to attend and free to improve his knowledge of mathematics, and to read such classics of physics as Helmholtz's *Sensations of Tone*, Rayleigh's *Theory of Sound* and Ewing's *Magnetic Induction in Iron and other Metals*. To this period also belongs Venkata Raman's first debut as an independent scientific investigator. *The Philosophical Magazine* of London for November, 1906, contains his first formal paper on *The Unsymmetrical Diffraction Bands due to a Rectangular Aperture*. In this and other work of the same period, we see the beginnings of his career in research and his deep interest in the sciences of optics and sound which has survived unabated till the present time.

At that time the only superior service which was open to Indians of talent without necessitating a qualifying period in England was the Indian Finance Department. As there seemed to be no possibility of a scientific career, Raman decided to sit for the competitive examination for the Finance Department. Accordingly, he prepared for it during his second year M.A. course, reading books on literature, economics, history and other subjects. In the M.A. degree examination in January, 1907, Raman secured a first class, obtaining record marks in his subject. He next sat for the Finance Examination in February, 1907, and here again secured the first place.

For the next ten years, Raman was an officer of the Indian Finance Department, serving successively at Calcutta, Rangoon, Nagpur and again at Calcutta in diverse capacities. He acquired very varied experience and knowledge of such matters as currency and remittance operations, salary and pension audit, the theory and practice of life insurance, the management of savings banks, the issue of government loans and the preparation of official budgets. At a very early age he was put in independent charge of large offices and found that even in his official work there was some scope for the exercise of initiative, originality and scientific thoroughness. The unusual qualities of the young officer did not lack appreciation in the department. Indeed, on several occasions Raman received the thanks of his official superiors and of the Finance Member of the Government of India. He also received an invitation to join the Secretariat of the Department, but declined the offer for reasons that will presently be clear.

Though his official duties took up most of his time, Raman's zeal for scientific work never suffered diminution or eclipse. From the very first he was on the look-out for opportunities for carrying on the experimental investigations begun by him at college. Soon after he joined the service at Calcutta, he discovered the existence of the Indian Association for the Cultivation of Science in that city and sought an interview with the son of the original founder, Dr. Mahendra Lal Sircar, who was then secretary. To his great joy he obtained permission to work in its laboratories in the mornings and evenings, out of office hours, and made the fullest use of these opportunities. Even when he was transferred out of Calcutta, first to Rangoon and then to Nagpur, Raman continued his investigations, converting part of his house into a laboratory and working with improvised apparatus. Fortunatelv he was transferred back to Calcutta towards the end of 1911 and thus regained the facilities offered by the Science Association. The latter remained the chief centre of his activities for the next twenty years. The steady stream of original papers coming out from the laboratory of the Association soon established Raman's reputation as an investigator.

Raman's enthusiasm for scientific work and his success in original research despite many handicaps, could not fail to attract the vigilant eye of the late Sir Asutosh Mookerjee, the then Vice-Chancellor of the Calcutta University. When the Palit Endowment Fund was created and Sir Asutosh wanted a Professor capable of organising and directing research to fill the chair of Physics, he thought of the young finance officer and offered him the post. Although Raman knew that from a pecuniary point of view he would be a great loser, he did not hesitate to accept the offer. It may be worth while here to quote the speech made by Sir Asutosh Mookerjee on the occasion of the laying of the foundation-stone of the University College of Science in March 1914:

"For the chair of Physics created by Sir Taraknath Palit, we have been fortunate enough to secure the services of Mr. Chandrasekhara Venkata Raman, who has greatly distinguished himself and acquired a European fame by his brilliant researches in the domain of Physical Sciene, assiduously carried on under the most adverse circumstances amidst the distraction of pressing official duties. I rejoice to think that many of these valuable researches have been carried on in the Laboratory of the Indian Association for the Cultivation of Science, founded by our late illustrious colleague, Dr. Mahendra Lal Sircar, who devoted a lifetime to the foundation of an institution for the cultivation and advancement of science in this country. I shall fail in my duty if I were to restrain myself in my expression of the genuine admiration I feel for the courage and spirit of self-sacrifice with which Mr. Raman has decided to exchange a lucrative official appointment for a University Professorship, which, I regret to say, does not carry even liberal emoluments. This one instance encourages me to entertain the hope that there will be no lack of seekers after truth in the Temple of Knowledge which it is our ambition to erect."

Raman joined the Calcutta University as its professor under the Palit Trust in July, 1917. On the death of Mr. Amrita Lal Sircar in November, 1919, he was elected as secretary of the Indian Association for the Cultivation of Science. These two positions, one of them salaried and the other honorary, supplemented each other most usefully. The professorship freed him from the vexatious necessity of earning his living at the desk of a Government office. His position at the Science Association enabled him to carry on research in the most congenial surroundings undistracted by the routine of teaching and examinations The terms under which Raman held the Palit Chair did not require him to take part in the ordinary work of instruction at the University College of Science. Nevertheless he found it of advantage to undertake a fair share of this lecturing. The closer contact with the subject and with the students which lectures gave was found to be highly beneficial and did not appreciably diminish the time and energy available for original research. It was these favourable conditions of work that were largely responsible for the outstanding successes of Raman during the fifteen-year period from 1917 to 1932.

The personal enthusiasm for research which led Raman to choose a life of scientific toil in preference to a lucrative official career soon overflowed and fertilised the minds and careers of a host of young men who came under his influence at the two institutions between which he divided his time. A school of research in physics rapidly grew up at Calcutta whose publications attracted wide attention, bringing recognition and honours for Raman, and advancement in life for his collaborators. This, in turn, enabled Raman to attract a larger number of highly-qualified workers and to secure further resources for the equipment of his laboratory. The atmosphere of high scientific endeavour thus created under Raman's leadership proved itself in the sequel to be favourable for the attainment of outstanding scientific success.

No account of this period of Raman's life would be complete which did not give some account of the great discovery made by him in 1928 and of how he was led up to it. The phenomena of light and colour had from the first been of the deepest interest to Raman and had been the subject of many researches by himself and his collaborators. His long residence at Waltair and at Madras had made him familiar with the varied colours of the sea in the vicinity of land. During his first brief visit to Europe in 1921, he travelled over the deeper areas of the Mediterranean Sea ; noticing with surprise the intense blue colour of its waters, he became deeply interested in the question of its origin. It suggested itself that the colour was incidental to the process of the diffusion of sunlight in its passage through clear water, and experimental support was soon forthcoming in support of this hypothesis. This led, naturally, into an intensive study of the diffusion of light in liquids and other transparent substances. This subject and various issues connected with it occupied the attention of Raman and his collaborators continuously for several years following. Gradually, from these experimental studies, a new phenomenon emerged, namely that in the process of diffusion, light may also change its colour. This was observed as early as 1923, but it was not until towards the end of 1927 that it became clear that this was a universal phenomenon and was entirely distinct from the well known effect of fluorescence exhibited by many chemicals. The final step was taken by Raman in February, 1928, when he used the light of the mercury lamp for these experiments, and found in the spectrum of the light scattered by various substances, new lines or bands not present in the incident beam of light. These new lines or bands are now known as the Raman lines or bands, and the spectrum containing them as the Raman spectrum of the substance studied.

To quote the words of a reviewer in a British scientific periodical, "the discovery of the Raman Effect in 1928 opened a view of research which has almost paralleled the early history of work in X-rays and radio-activity." Mathematicians hailed the discovery with delight, as they saw in it a confirmation of the new quantum mechanics which they had framed to replace the dynamics of Newton. Physicists and chemists also received the discovery with enthusiasm as it provided unlimited opportunities for experimental research and opened new pathways of investigation in their respective sciences. In scores of physical and chemical laboratories all over the world, and indeed in every civilised country, the experiments on the Raman Effect were repeated and applied to the solution of a variety of scientific problems. So great was the interest in the subject that it gave a new stimulus to the optical instrument industry; the leading manufacturers vied with each other in designing and producing spectrographs specially adapted for work in this field. In the ten years which have elapsed since the discovery, several treatises, dozens of monographs and over seventeen hundred separate original papers have been published upon the Raman Effect in various parts of the world. This stream of original work continues to flow unabated year after year.

It is not possible in such a brief sketch to survey the numerous contributions to science which have secured for Sir C. V. Raman a position of acknowledged eminence in the world of science. He has not followed established paths, but made his own way into many different fields of research, and opened new roads of advance. The outstanding qualities of his work have been originality and versatility. He has been a theorist as well as an experimenter.

The research papers published in the last twenty years by Sir C. V. Raman and the collaborators in his laboratory during the period of his professorship include over 600 titles, and the topics with which they deal indicate an astonishing catholicity of scientific interests. The investigations concern themselves with subjects so diverse as the dynamics of vibrations and sound, the theory of musical instruments, special diffraction problems meteorological and colloid optics, X-ray diffraction in liquids and solids, magnetism and magne-crystallic action, electro-and magneto-optics, dielectric behaviour and ultra-sonics. In all of these subjects, the researches of his school have notably influenced current progress. It is not feasible within any reasonable limits of space to review them even in broad outline.

The majority of investigators are individualists by nature, but a few are born leaders. Sir C. V. Raman belongs to the latter category. Impressive though his own personal contributions to science have been, his greater achievement is the work he has done in inspiring a whole group of investigators and creating a distinctive school of research in India. During the past twenty years, well over a hundred young men have been personally initiated into research by him These young men have been drawn to his laboratories from all parts of India, and they have been encouraged to engage in independent research and to put forth their own individual efforts with just the right kind of stimulus and assistance from their teacher. This policy has proved remarkably successful in bringing out their highest qualities and securing for them academic distinctions. They occupy high positions everywhere in India on the teaching staff of the universities and colleges, and in the scientific services of the Government, and they have easily held their own in comparison with the products of foreign research schools. Much valuable scientific work is being done in India to-day by Raman's former students not only in pure physics, but also in its applications such as meteorology, seismology and soil physics

One of the ambitions of Sir Venkata Raman has been to secure a prominent place for India on the scientific map of the world. As a step forward he realised that opportunities should be created in the country which would provide competent investigators, trained in India or elsewhere, with scientific careers, for the furtherance of their researches. Accordingly, it has been his ceaseless endeavour to create independent schools of research all over the country, to stimulate interest for research of a high standard in the universities and the scientific institutions and to staff them with men of proved ability in research. The Indian Association for the Cultivation of Science owes to his administration the permanently-endowed professorship of physics—now held by one of his most distinguished pupils—a well-equipped research laboratory, a fine library, and a substantial annual grant from the Government of India which enables its work to be carried on. At the University College of Science, Calcutta, he has left a staff largely composed of his former pupils and collaborators, a finely-equipped department of physics, and a great tradition for his chair to be maintained by his successors He has taken a very special interest in the welfare of the Andhra University and played an active part in the development of the University College of Science and Technology at Waltair. In his present sphere of activities at Bangalore, Sir C. V. Raman has been able, in a short time and at a minimum of expense, to build up a research centre in physics which has already to its credit a notable record of scientific achievement.

With the rapid increase in the volume of research work in fundamental sciences in India, the need for a periodical was keenly felt and was partially met by the issues of *Bulletines* and later of *The Proceedings of the Indian Association for the Cultivation of Science* by Sir C. V. Raman. From 1926 onwards, this periodical was issued under the name of *The Indian Journal of Physics* and contained the greater part of the research work of Indian physicists. On his removing from Calcutta to Bangalore in 1933, Professor Raman found it difficult to edit the *Journal* and to personally supervise the publications from at a distance, and he was therefore obliged to transfer its control to the men on the spot. At the same time, the creation of an active centre of research under his direction at Bangalore, and the increased productivity in research in many of the younger universities in India, prompted him to start the Indian Academy of Sciences in 1934. Under his fostering care the Indian Academy has, during the past four years, published its proceedings promptly and the end of every month, and has provided a medium in which a considerable volume of the scientific work done in India to-day is being regularly published.

The world has not been slow to recognise the importance of the achievement of Sir C. V. Raman as an investigator and a leader of scientific research. Scarcely had he completed six years as a professor of physics when the Royal Society of London elected him as its fellow in 1924. He was knighted by the British Government in 1929. He was the recipient of the Matteucci Medal of the Italian Society of Sciences in 1928, of the Hughes Medal of the Royal Society in 1930, and in the same year he was awarded the Nobel Prize for Physics. He has received *honoris causa* the D.Sc degree of the Paris University, the LL.D. degree of Glasgow and the Ph D. degree from Freiburg. The Universities of Calcutta, Bombay, Madras, Benares and Dacca in India have also conferred honorary doctorates on him. He is an honorary fellow or member of various learned societies, including especially the Royal Philosophical Society of Glasgow, the Zurich Physical Society, the Royal Irish Academy, the Deutsche Akademie of Munich and the Hungarian Academy of Sciences. He is also an honorary member of the Indian Mathematical and Chemical Societies and of the Indian Science Congress.

A remarkable fact about the life of Sir C. V. Raman is that he started his career as an investigator without any external stimulus and attained eminence as a scientist by his own individual effort, sustained by the work of his devoted pupils. The fact that he had no training in foreign laboratories endowed him with a power born from within and an originality in moulding the career of young men. In later years his ripe experience as a scientific leader was enriched by his frequent travels outside India, which have afforded him opportunities of visiting the leading research laboratories and

of cultivating personal relations with the leaders of Europe and America. His first visit to Europe was in the summer months of 1921, when he attended the Congress of the Universities of the British Empire held at Oxford. In 1924 he was invited to open a discussion on the Scattering of Light at the Toronto meeting of the British Association and of the International Congress of Mathematicians. Following this meeting, Raman visited the United States to represent India at the Centenary of the Franklin Institute at Philadelphia. At the invitation of R. A. Millikan, he spent four months at Pasadena as a Visiting Professor at the California Institute of Technology before returning to India early in 1925. In the autumn of 1925 Raman again visited Europe, as the guest of the Russian Academy of Sciences, to represent India at the Bicentenary celebrations of the Academy in Leningrad and Moscow. In 1929 Raman was invited by the Faraday Society to open a discussion on molecular spectra at Bristol, and took the opportunity of visiting and lecturing at many centres of learning in Europe. He subsequently visited Europe in the winter of 1930 to receive the Nobel Prize at Stockholm ; in 1932 to receive the honorary Doctorate at Paris ; and in 1937, as an invitee to take part in the International Congress of Physics at Paris and Bologna

The life of Sir C. V. Raman has been one of unswerving devotion to the pursuit of knowledge and of unceasing service to the cause of science and the promotion of research in India. The award of the Nobel Prize represents the considered judgment of the scientific world on the fundamental character and enduring importance of Professor Raman's contribution to science. It places his name in a select list of famous men, the record of whose discoveries is also the history of modern science. ☐

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RAMAN AS AN EXPERIMENTAL PHYSICIST

D. M. BOSE

DURING his stay in Calcutta Raman made his two major discoveries of light scattering in transparent liquids and solids, superposed on which a new type of modified scattering was observed not due to flourescence of any minute impurities present.

The experimental technique employed for such observation consisted of (i) source of radiation—sun light with complementary filters, and later quartz mercury arc lamps, (ii) the scattered radiation could be observed visually or more comfortably with a spectrograph using photographic plates sensitive to the visible and the ultra violet regions.

The modified radiation studied by Raman and others who followed him gave information on the rotation and vibration spectra of liquids and solids occurring in regions which could be visually observed or more comfortably with spectrographs sensitive to the visible and the ultra violet regions.

As a consequence the Raman effect was quickly employed by physical chemists to explore the vibration and rotation spectra of molecules and thereby their structure. In fact so popular was the technique that within a few years the number of papers published in this field swelled over a thousand ; in the physicist community interest decayed rapidly once the basic nature of the effect was delineated, and barely half a dozen groups scattered over the world continued to study and employ the Raman effect for problems in physics.

The situation changed dramatically following the invention of the laser. G. Venkataraman has described the advantages of employing a wide choice of near monochromatic laser radiation available in the visible region ; their extreme monochromaticity, high directivity gave additional advantages. In addition there had been improvements in the photoelectric detection and recording of light signals. The hitherto dormant interests of the physicists were aroused and a great spurt of activity followed.

A new region of investigation of the second Raman effect in transparent solids, in semiconductors etc. opened out for investigation—it is not within the competence of this writer to deal with this development.

The Raman Research Institute began functioning in 1949. About a decade later the use of gas laser for discovery of the second Raman effect phenomena was in full swing. A. Jayaraman who was associated with the Raman Research Institute during the period 1949-60 has given an interesting account of the equipment with which Raman with his team worked. "During my stay I had the privilege of assisting him in many of the optical and X-ray studies on gemstones. He had a fascination for opals, labradorite and moonstones.

"He often worked with very simple equipments. For instance, when he needed a powerful beam of light he always turned to the sun. It took a a year-and-a-half after I joined to bring electricity to the Institute. This did not deter Professor Raman from doing research. A pair of polaroids, a heliostat to reflect the sunlight, a pocket spectroscope, an optical cell and a darkened room, were all that he needed to start a study of even the most complex optical phenomena".

During the period 1928-48 Raman had not seriously thought of improving either the technique of light production or of detection, for investigation of his new effect. He apparently believed that his original equipment sufficed to provide data out of which a first class investigator could deduce all that could be discovered in this region of Raman effect.

Here one may discern a certain rigidity in Raman's way of thinking which hampered his following up of the implications of his new discovery.

To elucidate my criticism, I cite the instance of Lord Rutherford, a contemporary of Raman and one of the greatest of experimental physicists.

One of Rutherford's most important contributions has been the study of the impact of high energy positively charged particles on matter and the observation of scattering and nuclear disintegration resulting from such impact

His investigations could be divided into two periods. The first period which lasted upto 1917, was based upon isolation of charged particles from radium and other radioactive substances and using monochromatic charged particles mainly from RaC to study their passage through gases and thin foils of metals and studying their scattering.

Rutherford showed that α particles are doubly charged helium nuclei, whose mass and velocity could be experimentally determined. Most of the important results were obtained by Rutherford using very elementary gadgets. The α particles were counted by the scintillation they made on zinc sulphide screens. They were visually counted by an observer with a low power microscope.

From large angled scattering of the particles in absorbing foils Rutherford made the important deduction, that the positive charge in an atom was concentrated in a small sphere of radius $\alpha 10^{-18}$ cm. From which the conclusion followed that to break up a nucleus, the impinging positively charged particles must have a kinetic energy sufficient to overcome the repulsive force at the nuclear surface.

Based on this, Bohr's atomic model conceived the atom to be a planetary system with a concentrated positive charge at the centre, round which an equal number of electrons moved in stationary orbits, with their angular momenta multiples of Planck's quantum of action '*h*'. This formed the basis of Bohr-Sommerfeld's classical quantum theory of hydrogen like atoms.

Rutherford in 1917 was able to disintegrate the nitrogen nucleus by bombarding the gas with fast α-particles. These results were based mainly on Rutherford's own observations using the simplest of instruments.

The second part of his investigations on the energy of disintegration of light atoms were carried out in the Cavendish Laboratory which Rutherford joined after the first World War.

He provided facilities to Cockcroft and Walton to build up a steady high voltage source using a voltage doubling circuit designed by Greinacher.

At the same time fast counting of ionizing radiation using valve tube arrangement was also introduced. Cockcroft and Walton built up a generator whose voltage could be varied stepwise upto 600 kv. On radiating some light atom targets, they observed that secondary particles were observed on a scintillating screen at voltages much lower than that required to penetrate the nuclear core on Rutherford's model of the nucleus. There were nuclear particles from the disintegrated nuclei. About that time Condon and Gamow had shown that such a result could be accounted for according to the new quantum wave mechanism.

These investigations at the Cavendish Laboratory under Rutherford's directorship would correspond to the discovery of second Raman effect by the application of gas laser. □

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TRIBUTES TO SIR C. V. RAMAN*

Prof. S. D. Chatterjee

Former Professor & Head of the Deptt. of Physics, Jadavpur University

WE meet on a solemn occasion, we have assembled here to celebrate the diamond jubilee of the discovery of the Raman effect. It was on 28th February 1928, when we were students of Presidency College and living in Hindu Hostel we learnt that Prof. Raman had delivered a lecture in Madras about some kind of new radiation and the next day it was published by the Associated Press that he had discovered new lines of scattering. We, from Hindu Hostel, some of our own students were very interested and we went to 210 Bowbazar Street and Asutosh De, an assistant of Prof. Raman, who never entered into the portels of the university, showed us the Raman effect. It was just like this: he had a Hg lamp, it was focussed and a filter was put so that the ultra violet line 4390 passed through and at right angles in the invening place there was a flask full of toulene. He put another filter so that to extinguish 4390 and the green light flashed so we were told that this was Raman effect.

Prof. Raman, as a matter of fect, when he was persuaded to go to England in 1921 (normally it was the duty of the Palit Professor to have a foreign training but Prof. Raman refused to go and so Sir Asutosh Mookerjee had to modify the constitution) to attend an university's conference and there while crossing the Mediterranean he found that the sea was very blue and he thought that this cannot be explained by Raleigh scattering. Raleigh said that it was due to the reflection of the sky but Raman thought that it cannot be because it was very blue so when he was coming back he took Nicol's prisms, polarise and analyser, and at a particular angle the light should be quenched, he found that it was not quenched and he came back and he started his work on scattering.

His first research worker was K. G. Ramanathan from Madras University, he was his first scholar. He later on became the director general of meteorology. Mr. K. G. Ramanathan, had a big chamber—I saw that also, covered on all sides with a hole on one side and sun light was focussed through the hole. And it fill on a piece of glass bulb in which ethyle alcohol, methyl alcohol and water were placed. And at right angles he saw with another filter that a weak ray was coming. But with different wave length. But he thought it was because of fluorescence. That was in 1922 and K. G. Ramanathan got his doctorate on that work in a record time of one year. After that Raman purused his research.

Inspite of several purifications they could not get rid of the weak fluorescence. When Asutosh Dey showed us the lines the picture was taken by K. S. Krishnan. In the picture, in addition to the line there was a band and some fine lines also. So when Raman came and saw that, he said that it was a chance of a life time. He asked the glass blower to buy all the chemicals that were available in the market. He used to live in a lane just beside the Science College—Harkata gali, we used to go there also. Sir C. V. Raman brought a khatia and spent several nights at the association. He irradiated several samples and got the band and the fine lines. He anticipated the Nobel Prize for this work.

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*At the Momorial Meeting held on 1 November, 1988 organised by Calcutta University.

Before the Nobel Prize award was given to him he got a ticket for himself and his wife, two months in advance. He went to Stockholm to receive the award. When he came back, at a party in the mathematics department, Raman was like a boisterous child, he said that in 1924, when he got the fellowship of the Royal Society Sir Asutosh Mookerjee hosted a dinner for him and he had asked why a dinner for the fellowship of the Royal Society; if he waits for six years more and he (Raman) would get the Nobel Prize and in fact, he got it. Then he said, he, a non-aryan could get the Nobel Prize, how much you aryans could get. He got the Nobel prize in 1930.

In 1929 he was the President of the Indian Science Congress held at Calcutta and a tour was arranged to go to Santiniketan and our guide was Prof. P. C. Mahalanobis. Raman was accompanied by his wife Lokasundari Ammal. He walked very fast and then he looked behind for his wife and marked time to go together. In Rabindranath's room there was musical soiree and dance. Rabindranath Tagore asked Raman, you had been in Bengal so long, you speak to me in Bengali. Raman could not speak and his wife spoke fluent Bengali. Raman was my examiner in B.Sc. (honours) practical examinations held at the University College of Science and also he was my examiner of the M.Sc. thesis.

Raman is to believe something in astrology and an astrologer once said to him that number seven was his lucky number. He was born on November 7, 1888 and 1907 he passed the M.Sc. examination 1st class first with record marks; 1907 he passed the finance examination in Calcutta; 1907 he joined the service, and in the same year he was passing through Bowbazar and when he saw the IACS 210 (that is also a multiple of 7) Bow Bazar Street and then he became the Palit Professor in 1917 and left Calcutta in 1933 and went to Bangalore. I saw him at Bangalore also. He was riding a bicycle and his wife, with a glass of milk, was running after him. He complained that there was too much of noise in the house. Why is the boy (his son) shouting? "He is shouting for fees. He is appearing for the B.Sc. examination", told his wife. "What? Has he passed his matriculation examination?" was Ramman's exclamation.

Raman continued that work and he always worked with simple materials. Even the light of the night sky he studied with Nicol's prism and last of all he worked on the physiology of vision and he thought that it is enough to get a second Nobel prize. But it was not published by the Royal Society of London so he resigned his fellowship of the Royal Society. But the resignation was not accepted. Raman at the age of 82 breathed his last, in 1970 on 21st November, all multiple of seven. What the astrologers had said was true. I had the good fortune of coming in close contact with Prof. Raman when he get the Nobel Prize I sent him a congratulation letter as a 5th year student. His response was immediate. Raman's letter—"My dear Chatterjee kindly accept my heartful thanks for your congratulation. Yours sincerely C. V. Raman, 210 B. B. Street". Thank you.

Prof. N. N. Dasgupta

Former Palit Professor of Physics, Calcutta University

I was a M.Sc. student of Prof. Raman and later on I had the privilege of working in the Indian Association for the Cultivation of Science (IACS). Today I am glad to have this opportunity of speaking to you about some of my reminiscences about him, about my professor and a great scientist. I was a student in the M.Sc. Physics Dept. of Calcutta University during the year 1930 and 31 when Prof. Raman received the highest honour, a scientist could aspire.

Prof. Raman used to take our classes in modern physics in those days. He had a very impressive appearance. With a turban over his head, a prominent tilak on his forehead and two very bright intelligent eyes. He had phenomenal memary and did not require any notes during his one hour lecture. He was always deeply absorbed in what he talked and talked in such a lively manner that we all listened with great attention. And when the class ended we always wished that it had continued a bit longer. Sometime he used to take extra care for his students. Once I remembered he borrowed a large diamond from the Maharajah of Burdwan & demonstrated it in the class to explain some point in light scattering. On another occasion he asked us to assemble in IACS laboratory in the evening where he would demonstrate some experiments set up by him. The announcement of the award of Nobel Prize for Raman appeared in Calcutta Press sometimes towards the end of 1930. As students of the Physics Department naturally we were all very proud and jubilant and expected that there would be no class in his honour but our professor appeared as usual at the right time next day and took his classes, still enough to be least perturbed and hardly said a word about this wonderful event.

In the M. Sc. examination in physics I stood first and requested him to allow me to do research under him in the IACS. In his characteristic manner he said the results were not at all good but I must first prove that I had real love for physics. "Please bring to me the M. Sc. text books that you have purchased and read during the last two years." When I showed him these, he went through them very carefully looking at the portions that I had marked important. Half an hour's scrutiny he seemed to have satisfied. And he said I might join IACS as a research worker under him but there would be no scholarship that he could offer me. So I started work as a honorary research worker in the IACS. My professor was as careful in the selection of his research students as he was in writing his papers in physics.

Prof. Raman used to spend the whole day in the IACS laboratory. He came right after breakfast and when we came at 10 in the morning he was already discussing some experiments which had been done or plans for the new experiment. When we were leaving at 7 O'clock-8 O'clock in the evening he was deeply studying in his own room. One day I was bold enough to ask him—"Professor, you are spending the whole day in the Institute reading texts and journals of physics. Don't you ever take any time to read any novel or literature ?" Quick came the reply ; "the only novel that I ever read is Round the World in Ninety days by Jule Verne and that was when I was a student". In later life I often thought about these words of my professor and what a man he was. Physics was his life star. His whole mind and thoughts were constantly focussed on physics and physics alone. He had no time or desire for anything else in life. I will also never forget what he said on another occasion. The time was when Raman had just returned from Sweden after receiving the Nobel prize award. Speaking about his experiences in Sweden there in a brilliantly illuminated Hall, the band was playing in honour of 5 Nobel laureates assembled from different parts of the world. And they were being greeted by the king and queen of Sweden. The contrast with this treatment and the one he used to get from the foreign rulars of our country was so great that he could not control himself, tears came to his eyes. After a few minutes he was sobre again and the following sobring thought occurred to him—Sweden awards five Nobel prizes every year, and the Indian population is nearly 1/6th of the total world population. When in original thought and original discoveries we could become equal to the people of the world, at least one Nobel prize should come to us every two years. This was his sobring thought and this was the standard of excellance visualised by my professor sixty years ago, for the scientists of future India. However, during the last sixty years the constraint of foreign rule has gone, the number of universities, IIT's, national laboratories and Institutes of excellence have increased. Grants for educational research have gone up enormously. But we have not yet been able to reach the standard of excellence visualised by Prof. Raman sixty years ago. We have not been able to produce another Raman in our country.

Prof. A. D. Buckingham

Professor, Oxford University in delivering his lecture on Raman scattering and Molecular polarizability paid tribute to Prof. Raman

I have the privilege and pleasure to participate in the celebrations in Calcutta firstly here in the University and later in the week at the Indian Association for the Cultivation of Science (IACS). Raman was, as you heard one of the great scientist of the world. He has taught us important lessons of science. His appreciation of the simple experiments, his eagerness to learn and to dispel a shortage of understanding. I think that is the key feature of a great scientist. One has to be curious, and has to want to learn and understand nature and one's dissatisfaction at the understanding, discoveries may be made.

The Raman effect, as you know, discovered in 1928, here in Calcutta and at that time there was feverish activity in physics. The quantum theory, the quantum mechanics essentially in the form that we know it was formulated a few years before in 1926 and we had in that same year Krammer - Heisenburg formula for dispersion so the interaction of radiation with matter was already understood to some extent through that formula. Ofcourse the work of Raleigh in the last century, had paved the way for the investigation of elastic light scattering. So the classical theory of light scattering had been well established through the work of Raleigh following Maxwel's great theory of electromagnetic radiation. But to the Raman effect it was essential that we had quantum description of matter in order that we could interpret the inelastic scattering that is the basis of Raman effect. And that was formulated in Cambridge by Paul Dirac in 1928 only after the discovery of Raman effect.

For those who are not familiar with the Raman effect let me first tell you what it is : we have an incident light beam, it is polarized in a direction so the electric ractor E_A is in this case verticle ; polarised beam of light falls on a sample to be investigated and we detect the scattered radiation usually at right angles to the propagation. We have a monochromater here and a detector. In the earlier days, the detector would have been the photographic plate which has some advantage ; it is not a very linear detector, it is not so good for measuring intensities. Now-a-days we would normally use photo-electric recording and in a sense we buy an instrument which contain this detection system as well. In those days Raman scattering was very weak, it is still very weak, it is not stronger now and although there is feverish activity for a few years following Raman's great discovery, the study of the Raman Effect settled down to a steady state which was only of moderate intensity and the reason for that was the relative weakness of the effect compared to, for example, infra-red absorption. IR absorption provided a much more sensitive method of detecting vibration & rotation of molecules. So Raman scattering was an important technique that really took on a new lease of life with the discovery of the lasers in about 1960, so we have a much improved light source. Instead of having a Hg arc or even a sun, one has a highly monochromatic polarised and parallel beam of radiation. It was the perfect source for Raman scattering experiments. Coupled with that advance is the development of improved detector. So that we now have all the advantages of modern electric gadgetry to enable us to detect and process the scattered light. So we don't only observe the frequencies and intensities we can also observe time delays, we can have post light source, we can turn it off and we can study the motions of scattering molecules by highly resolved Raman scattering. Thus we now have extremely versatile and powerful means of probing a vibration and rotation of matter and indeed the electronic structure of matter. Now in my talk I am going to concentrate on the theory of Raman scattering, which is my speciality, although I am also actively involved in some simple experiments. I think Raman to appreciate simple experiments and I understand that he was not at all happy when an explanation of great complexity was presented for a physical phenomenon. He became impatient with that and always saw a simple clear explanation to which great scientists are noted. Complete understanding generally leads to simplicity. □

PROFESSOR RAMAN

The First Palit Professor of Physics

KEDARESWAR BANERJEE

THE Scientists of the world are mourning the demise of Professor C. V. Raman on November 21, 1970 at the age of 82.

The Physics Department of the Calcutta University more than half a century ago was extremely lucky in having the greatest scientist of India and one of the top scientists of the world as its first professor, the brightest period of whose scientific contributions was the tenure of his Palit Professorship here. As I had the great fortune of being associated with him during a considerable, part of this period I shall concentrate here mainly on the Calcutta chapter of his life.

The earliest opportunity of my meeting his was in the M. Sc. class of the Calcutta University Science College. Before that, when I was a student of the B. Sc. class at the Dacca College, reputation about his researches inspired me and I decided to go to Calcutta to study under him. I had to make this choice against the advices of my friends and relatives as just after my B. Sc. examination in 1921, the Dacca University was inaugurated with all the future prospects expected of a new University, I became convinced later that the choice was correct. His class lectures were wonderful experience for us. The enthusiasm with which he clarified the intricacies of Physics created in us an intense interest in the subject. I have

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never seen any other teacher to be so deeply absorbed in his subject during the lectures like him, he would forget every thing else in the world. We all became extremely enamoured of his lectures.

After the M. Sc. examination was over and the results were expected to be out, I went to meet him at the Indian Asssociation for the Cultivation of Science (popularly known as "Science Association"). He was very glad and informed me that I secured a first class and asked me if I was interested in accepting a Palit Research Scholarship. I was overjoyed at the offer and immediately accepted it and had thus the realisation of my aspiration of working under him

Prof. Raman was born on November 7, 1888 at Trichinopally. He stood first at the Entrance Examination and studied at the Hindu College and then at the Presidency College. He stood first in B. A. Physics Honours in 1904 and started research work after that. The first paper published by him was in the *Philosophical Magazine* in 1906. He was awarded the M. A. degree in due time but could not secure any teaching position where he could also carry on his research. So he appeared at the Indian Finance Service examination and stood first. He was posted in Calcutta in 1907. But all the time he was having a burning desire for carrying on Scientific research. He published two more papers, one in Philosophical Magazine and another in *Nature* by this time.

Opportunity for carrying on scientific research came to him in an unexpected way. For going to office and coming back he had to pass through Bowbazar Street where he saw the signboard of a house as "Indian Association for the Cultivation of Science". This interested him very much and one day he entered and met the Honorary Secretary Dr. Amritalal Sircar, whom he asked about the activities of the organisation and its objective. Dr. Sircar explained to him that this institution was founded by his father Dr. Mahendra Lal Sircar in 1876 by his immense efforts for disseminating scientific knowledge among the people and for scientific research to be carried on by Indians. Raman gave out to him his background and asked whether he may be permitted to carry on scientific research works outside his office hours. Dr. Sircar replied that he was very happy to permit Raman to carry on research work there but at the same time mentioned that the Association was too much financially handicapped to purchase sufficient scientific equipments. But that did not discourage Raman who said that he would carry on research with whatever apparatus was available.

The founder of the Association was man of colossal activity and whose thinking was much ahead of his time. With great energy he built up this Institution. As the time was not ripe for scientific research in India, he concentrated his activities to popularise science through lectures by himself and by other best talents available. Scientific research, however, began at the Association with the start of the present century in a modest way mainly in Chemistry. In this atmosphere Raman started his research activities on Acoustics. Dr. Sircar put all the resources of the Association at the disposal of Raman and arranged to keep the Association open from early morning till late at night, So it was possible Raman to work on holidays and on other days for some hours in the morning before going to office and some hours in the evening after returning from office.

Unfortunately soon there was a break in his research activities due to his being transferred to Rangoon by the government. He, however, was successful in coming back to Calcutta again without too long a gap and continued his work at the Association. After carrying out his studies at the Finance Department it was with great difficulty that he could find time for his researches. In order to get as much time for his research as possible he lived in a house just behind the Association although it was in a very uncongenial area. In this way he managed to publish a number of original papers in foreign scientific journals.

At this time Sir Asutosh Mookerjee the great Vice-Chancellor of the Calcutta University established the University College of Science in 1915 in order to raise the standard of scientific education and to create greater facilities for scientific research. For this purpose he founded professorship by obtaining donations from charitable persons. The first donations were from Sir Tarak Nath Palit for two professorships namely for Chemistry and Physics. For the Physics Professorship Sir Asutosh Mookerjee invited C. V. Raman who accepted it readily as he was very eager to have such an opportunity of whole time devotion to teaching and research. He resigned from the more lucrative government post and joined as the first Palit Professor of Physics in 1917. This was a memorable event in the development of Physical research in India

Even after joining as the Palit Professor of Physics his major activity continued at the Science Association so that the facilities of both the Institutions were at his disposal. He carried out in the beginning various investigation in acoustics including a wide range of stringed instruments such as violin, veena and other types of plucked, bowed and struck strings. The results were published in foreign journals such as *Philosophical Magazine* and *Nature* and also in the publication of the Science Association. His reputation spread far and wide, many research workers, teachers of the Calcutta University and other colleges were attracted to work here. Gradually scientists with urge for research began to come here from various parts of India mostly during vacations, but some as wholetime research workers.

After the death of Dr. Amrita Lal Sircar in 1919, Professor Raman was elected the Secretary of the Association. Although the administrative responsibility took some of his time, his research activities were no allowed to suffer. Sir Asutosh Mookerjee permitted him to use in the Association the research equipments purchased by the University for his research work as Palit Professor. This enabled him to widen the field of his activities, particularly to optics immediately. During this period up to the early twenties particular mention may be made of his collaborators Dr. S. K. Banerjee, Dr. N. K. Sethi, Dr. B. N. Banerji, Prof. P. N. Ghosh, Prof. S. K. Mitra, Dr. K. S Rao, Prof. B. B. Ray, among others who rose to eminence in their fields of research. I would like to mention here particularly the name of Asutosh Dey the then Assistant Secretary, Science Association who was Prof. Raman's constant helper in his research activities. Ashu Babu had no college education but had wonderful aptitude for carrying out experimental work. His resourcefulness for finding simple substitutes for costly sophisticated apparatus was remarkable In one of the published papers of Prof. Raman he was the co-author.

Science Association thus became a very active centre of scientific research. In optics his attention began to be more and more concentrated on scattering of light by solid, liquid and gaseous matters. He and his co-workers discovered many facts of fundamental importance in the line, particularly about molecular structure from measurement of polarisation of scattered light. Names of Drs. K. R. Ramanathan, K. S. Krishnan, I. Ramakrishna Rao and N. K. Sur may be particularly mentioned among his associates in this particular field. His fame for these investigation spread far and wide and he was elected Fellow of the Royal Society of London in 1924 The Government of India started in 1926 to give an annual donation of Rs. 10,000/- which was increased to Rs. 20,000/- per annum in 1927. The Association attracted larger and larger number of research workers from all over India and it became the topmost centre of physical research in India and at par with the best centres of the world.

While working on scattering of light by liquids he and Dr. Ramanathan observed by the help of balanced fitters that the scattered light unexpectedly contain a small fraction of light of different wavelength. Naturally they thought that the liquid contains some fluorescent impurity which is responsible for this modified wave-length. But repeated attempts at purification of the liquid was of no effect. The discovery of compton effect attracted Prof. Raman's attention about this time. He set upon to see whether there is any change of wavelength in light scattering as well. His uncommon power of eyesight helped him in observing the feeble change of colour of the scattered light. But to measure the actual change of wavelength it was necessary to study its spectrum. The only spectrograph that was available at the Association was a small one—"Baby Spectrograph". With the help of this small thing he made the very great discovery that a part of the scattered light was is wavelength changed. This result when published became internationally known as Raman Effect as the change of wave-length was found by Prof. Raman to be of a type very different from Compton effect. Dr K. S. Krishnan collaborated with him in this work and on their detailed investigation it was found that of the light quanta incident on the molecules some would excite them to higher energy level by losing a part of the quantum of energy and thereby changing the wave-length. The discovery opened up great fields of research in Physics and Chemistry as by its help molecular energy levels of chemical substances could be completely determined. Thus it became a powerful tool in determining molecular structures. Presently the Association became a very active centre for studying Raman Effect in its various aspects in solids, liquids and gases. His fame spread over the whole scientific world and he was awarded the Nobel Prize in Physics for 1930. Among his co-workers who carried out researches in the various aspects of Raman Effect in addition to Dr. K. S. Krishnan, the names of Dr. S. C. Sirkar, Dr. S. Venateswaran, Dr. L. A. Ramdas, Dr. S. Bhagavantam, Dr. A. S. Ganesan, Mr. A. Karl and Dr. P. Krishnamurthi are to be specially mentioned. A very large number of other Physical and Chemical Research Institutes all over the world took up research work on Raman Effect on a large scale.

This decade (1920-30) was the most glorious period of Prof. Raman's research activities for not only in Raman Effect but also in various other branches of Physics he initiated researches of far-reaching importance. One such field was that of Crystal Optics. I had the good fortune of being associated with him in one such problem as my first assignment as research scholar. This was the study of a peculiar pattern shown by amethyst quartz crystal plate under a polarising microscope. The phenomenon was explained in a novel way as a phase lamination diffraction effect. He initiated investigations into double refraction induced by electric and magnetic fields in liquids and gases and by flow of liquids and by anisotropic pressure on isotropic transparent solids. In collaboration with Dr. K. S. Krishnan he investigated theoretically the contributions of electric polarity and optical anisotropy of molecules to the electrical birefringence and that of the magnetic anisotropy of the molecules on the magnetic birefringence. He and Dr. I. R. Rao experimentally measured these effects in various liquids and there by determined the optical and magnetic anisotropics of the molecules of these substances. On his suggestion I studied the double refraction produced by anisotropic stress on isotropic solids in relation to their atomic arrangements.

Prof. Raman's interest in scattering of light led him to the study of scattering of x-rays by liquids. He and Dr. Ramanathan developed a theory of x-ray diffraction by liquids and amorphous solids which explained diffraction maxima observed by earlier workers. Their results were experimentally verified by Dr. C. M. Sogani working under Prof. Raman. Dr. Krishnamurthi in this laboratory, however, found a co-relation between the diffraction due to the solid and the liquid states of substances. I gave a modified version of the theory of Raman and Ramanathan taking into account the directional bonding forces between molecules to explain this co-relation.

Working under him, very interesting results were obtained by Dr. S. Bhagavantam from his measurements of the magnetic anisotropics of the crystals of naphthalene and anthracene structures of these crystals were published by Sir William Bragg earlier which were incompatible with Bhagavantam's results and Prof. Raman directed me to make a more systematic redetermination of the structures. The structure redetermined by me by X-ray diffraction was compatible with the results of Bhagavantam and accepted by Sir William Bragg as the correct one. For all these investigations the Raman School of research became internationally known not noly as a top place for light scattering crystallography, but also for solid state physics X-ray Diffraction in general.

During the long period of work of Prof. Raman in Calcutta it was very remarkable that he never waited for sophisticated apparatus from foreign countries. He tried to build up his equipments as far as possible in the laboratory or get them from Indian sources. Even for X-ray diffraction which requires fairly complicated apparatus and in early twenties of the persent century when technical know-how was in very preliminery stage, except the transformers which were supplied by a Calcutta firm all other equipments were made within the Association workshop. This adventure helped considerably the developments of Instruments Technology in India.

During the latter half of his Calcutta period honours poured upon him. Apart from being elected F.R.S. and award of Nobel Prize, he was awarded doctorate degrees honoris causa from many universities of Indian and abroad including the University of Paris. He attended as representative of India, the British Empire University Conference in 1921, and the centenary celebration of the Franklin Institute of U.S.A. in 1925. He attended as special invitee of the bicentenary celebration of the Moscow and Leningrad Academies of Science in 1925 and the British Association for the Advancement of Science in 1927. The Optical Scattering Section of the International Mathematical Congress in Toronto in 1927 was inaugurated by him. He was elected the General President of the Indian Science Congress of 1929. He was awarded the Mattenci Medal of the Italian Society of Science and the Hughes Medal of the Royal Society of London in 1922. The British Government Knighted him in 1929, but he did not like the use of "Sir" before his name.

Indian scientists were thinking about the question of publication of results of scientific research in India during the early years of this century. The Science Association began to publish some scientific papers in its Annual Reports. Later on, attempts were made to meet this demand by publishing occassional bulletins and transactions. But with expansion of research activities, the need for regular publication was more keenly felt and the Science Association under the inspiration of Prof. Raman started publishing a journal known as the *Proceedings of Indian Association for the Cultivation of Science*. By his untiring efforts this developed into a journal of high calibre and was named *Indian Journal of Physics* in 1926. It soon developed into a regular bi-monthly journal and occupied an important position among leading scientific journals of the world through his constant efforts.

Prof. Raman joined the Indian Institute of Science and Technology of Bangalore as its first Indian director in 1933. Even after going to Bangalore he continued his interest in the Association as its President. Before he left Calcutta, the future of the Science Association was in his mind and by making an all effort he was able to create an endowed Professorship designated as the Mahendra Lal Sircar Professorship and appointed Prof. K. S. Krishnan as the first Mahendra Lal Sircar Professor. But on account of some misunderstanding with the members of the Association he ceased to remain the President and unfortunately he cut off all connections with the Association, but his love for the Association lingered. Even during the most busy period of his building up his own Institute at Bangalore he had once to pass through Howrah where he had to halt for a short while, he came straight to the Association at Bowbazar. I was the Mahendra Lal Sircar Professor at that time. He came to me and ordered me to arrange for assembling the research students immediately. He straightway lectured to them for an hour or so and explained his latest work to the students, had coffee and quickly returned to Howrah to catch his train. The transfer of the Science Association from Bowbazar to Jadavpur pained him very much and he gave up his life-membership of the Association as he considered it to be an end of the great traditions that were built up with so much efforts during the previous 3 quarters of a century.

The towering personality of Prof. Raman inspired a large number of scientists from all over India to the path of devotion to Science. His speeches were immensely illuminating and when he talked to us we were always highly impressioned by the clarity and novelty of ideas and an uncommon talent for going deeply into the fundamentals of any problem. Scientific research was his all-embracing passion and he rarely thought of anything else. His all-out devotion to science was unique.

We, the students of Prof. Raman saw him in the laboratory very early in the morning and he went home late in the night. We never saw him taking rest during this period. For going to Science College he used to go home take his meals and come back in an extremely short time and then proceed to the Science College from the Association. He used to return from the Science College to the Association and at coffee-time would go home for only a few minutes. He discovered the Raman effect at about 1 A.M. in the night. During his work he would forget everything in the world. Interests of the Association and the University Physics Department were always superb in his mind. As the Association was not affluent in those days, he ungrudgingly met deficits of the Association from his personal Bank Account on several occassions.

As the director of the Indian Institute of Science and Technology considerable part of his time was taken up by administrative work which did not suit him. So after 4 years he left the Directorship and became simply Professor of Physics so that he could devote himself whole heartedly to research again. He continued in this position until 1943 when he built up a research laboratory of his design and liking, known as Raman Institute, and actively continued his research until death put a stop to his activities at the age of 82. His life and work have built up a great idea before our scientists and will inspire future generations of scientists to unflinching dedication. ☐

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REMINISCENCES OF MY ASSOCIATION WITH PROF. C. V. RAMAN

SUKUMAR CHANDRA SIRKAR

IT was in 1920 when I first came in contact with Professor Raman while studying in the Fifth year M.Sc. Class in Physics at the University College of Science, Calcutta. He took classes on Electricity and Magnetism and followed the well-known treatise by Jeans. He used to come to the class with a few sheets of paper on which the lecture notes had been scribbled, but he consulted these notes only occasionally during the lecture. Dr. L. A. Ramadas and Dr. K. S. Krishnan were my class mates at the University College of Science. Dr. Krishnan (then Mr.) and myself could not appear at the M.Sc. Examination in 1922 for different reasons, bur Dr. (then Mr.) Ramadas passed the Examination that year and started research work in the laboratories of the Indian Association for the Cultivation of Science and Krishnan also was appointed a Research Associate at the Association. While holding a permanent post in the Bridge Engineer's Office at Paksey, I used to come to Calcutta frequently and would meet both of them at the Association just to find out the nature of the problems they had been investigating. I finally appeared at the M.Sc. Examination in 1925, but unfortunately, I was not placed in the First Class, because I could not secure more than 56% marks in the Practical papers. I was, however, placed first in the Second Class, there being only one successful candidate in the First Class. When I approached Prof. Raman for a research scholarship he told me that he had already offered the scholarship to the candidate who had stood first that year. So, I had to wait for a future vacancy. In May, 1926 I received a letter from Prof. Raman informing me of the award of a Palit research scholarship for three years at a stretch as a special case. I accepted the offer and after resigning the permanent appointment at Paksey, reported myself for duty at the Association in the first week on July, 1926. I was first assigned the experimental investigation or penetration of light in the second medium during total reflection. This work was completed in a month and I was next asked to determine the permanent electric moment of a few simple organic molecules by Debye's method. I set up the apparatus required for the heterodyne null method in the laboratories of the Association and got results for three simple organic molecules. While this work was in progress I was appointed Research Assistant to Palit Professor of Physics with effect from January 1, 1927.

The paper dealing with the results mentiond above was published early in 1928, but I was asked to start investigations on another problem which was also related to time of relaxation postulated in Debye's theory of polar molecules. I shifted to the Palit Laboratory at the University College of Science and set up an apparatus for the study of Kerr effect in viscous liquids under radio-frequency oscillating field. At this time one day Prof. Raman came to my room before going upstairs to take his class and after handing over to me a quarter size photographic plate. asked me to measure the wavelengths of some extra lines present in one of the two spectrograms contained in the plate, using the Adam Hilger comparator which was available in the laboratory. He also told me that one of the spectra was due to direct light from mercury arc and the other was due to the same light scattered by benzene. I did not find any iron arc comparison spectrum on the spectrogram and there was no Hg line on the long wavelength side of the Hg line 4358A. I measured the distances of the new lines from the mercury line 4358A but as the dispersion in the region was about 35A per mm it was not possible to find out the wavelengths of the new lines with any accuracy. When Prof. Raman came back from the class I pointed out to him this difficulty He told me that there was no time to take another spectrogram with iron arc spectrum as comparison, because he would leave for Bangalore the same evening and he wanted to announce the discovery of the new radiation at a meeting of the South Indian Science Association which had been arranged to be held during his stay there. We actually did so without giving the wavelengths of the new lines and after returning from Bangalore got a paper entitled 'A New Radiation' published in the *Indian Journal of Physics*, Vol. 2, p. 387, 1928. He was the single author of this paper. It was explicitly mentioned in this paper that this new secondary radiation was analogus to Compton effect. It was also stated that each of the prominent mercury lines produced a single new line. These statements were made only because the complete spectrum of the light scattered by benzene had not been investigated and the difference between the new effect and Compton effect was not realised at that time. However, to prove that the new scattering is different from flourescence it was stated in the paper that in collaboration with Krishnan Prof. Raman had studied the intensity and polarisation of the new radiation and had found these to be different from those of fluorescence.

After the publication of this paper Krishnan was asked to study the spectra of light scattered by different compounds in liquid and solid states using a spectrograph much larger than the small spectrograph used by Prof. Raman in the original investigation. My work on Kerr effect was completed by this time and I was asked to shift to the Association and to set up a Shearer X-ray tube for an investigation on the Laue patterns due to iridescent crystals of potassium chlorate. While I was engaged in this work one day Prof. Raman was showing a plate to some of the workers in the laboratory and he hurriedly came to my seat also and after showing me the plate said "Krishnan has made half the discovery". The spectrogram showed some anti-Stokes lines on the short wavelength side of the exciting line besides the new lines on the long wavelength side observed earlier. In a few months, spectra of light from mercury arc scattered by a large number of substances in different states were investigated by different workers in the laboratory including Krishnan and the universal nature of the phenomenon was established beyond doubt. Another important event took place in the Calcutta University at this time. Professor Sommerfelt was invited to deliver a course of lectures on Wave-mechanics as a Visiting Professor of the University at the request of Prof. Raman. As it was a new subject we attended the lecture with much enthusiasm.

Even after the visit of Professor Sommerfelt no effort was made by either Prof. Raman or any of his collaborators to investigate the proper theory of the new effect which was being called 'modified scattering' by the workers of the Association. After Professor Sommerfelt had left for Germany one day Prof. Raman was seen moving about hurriedly in the halls of the Association with a copy of Naturwissenschaften in his hand. He showed everyone of us present in the laboratory an article entitled "der Raman Effekt" on page 597 of the issue written by Pringsheim. Prof. Pringsheim was an acknowledged authority on fluorescence and therefore Prof. Raman's joy knew no bounds when he came across this article. He told us that the controversy about the priority of the discovery of this new phenomenon was settled when the effect was named after him alone. This was in reference to the discovery of some new lines in the spectra of light scattered by some transparent crystals made by Landsberg and Mandolstam who published their results in 1929 but claimed to have announced the discovery in a meeting sometime in 1928. It was clear, however, that they did not understand the true nature of their discovery. Prof. Raman began to cherish the hope of winning the Nobel prize as the sole discoverer of the effect. For this purpose he wanted his name to be proposed by some senior Nobel Laureates. He approached both Sir Earnest Rutherford and Professor Seigbahn. I was personally shown a portion of the letter in which Sir Earnest had stated that the new phenomenon had been called Raman effect quite properly.

Even before the discovery of the Raman effect Prof. Raman was fond of delivering lectures on topics related to problems investigated by himself or some of his collaborators. Once he was invited by the Principal of Serampore College to deliver such a lecture in the College. Prof Raman chose "Haloes and Coronas" as the topic of the lecture and asked me to accompany him with the equipments required for projecting haloes formed by a cloud, produced in a flask, on the screen. We had to hire a taxi cab, because Prof. Raman had no car that time. It was summer and the roads were so hot that one of the tyres of the taxi burst somewhere in Uttarpara. While the wheel was being replaced by the driver we were strolling near a beautiful house on the bank of the Bhagirathi. A shady banian tree added to the beauty and calmness of the place. Prof. Raman was charmed by the beauty and said "I would be happy to have a residence at such a lovely place." I pointed out, however, the disadvantage of the long distance from the laboratory. We reached Serampore in time and the lecture was delivered in accordance with the schedule. The return journey was uneventful. I distinctly remember another lecture delivered by Prof. Raman after the discovery of the Raman effect. It was delivered in the old Senate hall of the Calcutta University which was packed to the full capacity. The sound-reflecting screen with its bullet mark was there but there was no microphone. The new discovery was the topic of the lecture. Prof. Raman had to shout at the top of his voice to make himself heard by the members of the audience sitting far away from the reflector.

After the discovery of the Raman affect I studied Laue patterns due to iridescent crystals of potassium chlorate, and later, I was asked to determine the structure of the crystal. We had to apply only the trial and error method in our laboratory at that time. When this work was in progress Prof. Raman went abroad and the work was completed before his return. When he returned we went to Howrah Station to receive him. On seeing me here he promptly accosted me and told me that my work on potassium chlorate crystals had been anticipated by Prof. Zachariasen who had published a Fourier synthesis of the crystal. I was sorry to learn this, because it was then not worthwhile to publish the results obtained by me and about a year's labour was wasted.

Krishnan left the Association in 1929 and joined the Dacca University as a Reader in Physics. Prof. Raman helped him in getting this post. After his departure I was asked to study the Raman spectra of some organic liquids and a spectrograph was also available for this purpose. I carried out the investigations and published a few papers in quick succession, but I felt that the quality of the contributions made to these papers was not up to the standard required for the D.Sc. degree of the Calcutta University. By some coincidence of chance I had the opportunity of improving the standard of my work as few months later. Before narrating this I give an idea here of the cooperation which Prof. Raman received from the Calcutta University Press in his attempt to get his name proposed by some members of the Nobel Committee for the award of the Nobel prize in Physics for 1930. Early in 1930 Dr. (then Mr.) Bhagavantam who had earlier investigated some problems on Raman effect was asked by Prof. Raman to write up a bibliography of the work done upto that time on this new phenomenon. The bibliography was ready within a short time and it was to be published in an issue of the *Indian Journal of Physics*. Since a few original papers were needed for this purpose some of us were asked to contribute some papers. My paper on the Laue photographs of potassium chlorate crystals were ready and it was decided to include my paper in the issue. Prof. Raman one day asked myself, Dr. Bhagavantam and some other authors to accompany him to the Calcutta University Press. We did so and he handed over the manuscript for the issue to Mr. Ashutosh Ghatak who was the Superintendent of the press at that time. The press was located in the rear portion of the old Senate hall at that time. In less than two hours the whole matter of the issue was composed and galley proofs were supplied to us for correction. We quickly corrected these proofs and waited for the page proofs. The page proofs were presented by 3 P.M. and after correction they were returned within half an hour. The final corrections were made by the compositors immediately afterwards. Prof. Raman gave print orders before 4 P.M. Orders for printing about 300 extra reprints of the bibliography were also given. The complete issue with the reprints was printed off next morning and delivered to the book binder. The reprints of the bibliography were circulated among the leading Physicists of the world. The bibliography undoubtedly impressed upon the physicists the importance of the discovery.

It was a memorable day when Prof. Raman received the news of the award of the Nobel prize in Physics for 1930 to him. He was sitting in his room just to respond to telephone calls from his friends and admirers and most of the workers of the laboratory including myself were sitting or standing before him. One of his colleagues came and asked for some sweets. Prof. Raman gave us a ten rupee note and we immediately fetched some sweets from Bhim Nag's shop. At one moment he lifted the phone and said 'Thank you Mr. Chunder. You will be glad to learn that your diamond did the trick'. Mr. Nirmal Chander Chunder was congratulating him from the other end. He had earlier lent Prof. Raman a big diamond the Raman spectrum of which was studied by Bhagavantam. As it was a big jewel it gave strong fluorescence and only one Raman line superposed on the continuous fluorescence spectrum was observed. Prof. Raman had been conferred knighthood in 1929 and after receiving the news of the award of the Nobel prize he told us that when he was knighted earlier he was sure the prize also would come to him.

As mentioned earlier I was not satisfied with the quality of the work on the Raman effect which I had been carrying on during the years 1930-32. In 1932 one day Prof. Raman showed me a review by Beams published in an issue of the *Review of Modern Physics* (p. 147) of the same year. My work on Kerr effect in viscous liquids under radiofrequency oscillating field had been reviewed in that article. He was pleased after going through the review and said that I should do some more important work so that it would be easy to get the D.Sc. degree. A few days later a junior scholar of the Association accidentally broke a Raman tube of fused silica which Prof. Raman had earlier procured for the study of the Raman spectra of liquids in the ultraviolet region. After this incident the scholar was so much frightened that he never turned up to do his work at the Association. Prof. Raman one day gave me another such tube and a quartz spectrograph and asked me to carry on some investigations on relative intensities of Raman lines with a view to verifying the polarisability theory put forward earlier by Placzek. I successfully carried out the investigations and published a few papers within a short time. Early in 1933 Prof. Raman left for a tour on the Continent and during his stay abroad I wrote up my thesis and submitted it to the Calcutta University for the D.Sc. degree. After his return from the Continent Prof. Raman was surprised to learn that I had been able to prepare my thesis and submit it during his short absence from the laboratory. However, he himself arranged for the appointment of Examiners to adjudicate upon the thesis and as a special case got his name included in the list of three Examiners, the other two of the list being Prof. McLenan of Toronto University and Prof. Peter Pringsheim of Germany. Prof. Pringsheim, however, returned the thesis after a month, stating in his letter that he had never worked on Raman effect and was, therefore, not competent to adjudicate upon the thesis. Prof. Raman at once got Prof. Ch. Fabry of Paris appointed as the third Examiner in place of Prof. Pringsheim and a copy of the thesis was also sent to him. A few days later the Registrar, Calcutta University received another letter from Prof. Pringsheim along with a report on my thesis. He had recommended that the thesis should be accepted for the D.Sc. degree of the Calcutta University. Immediately afterwards, Prof. McLenan also sent a similar report. Prof. Raman, however, asked the Registrar to wait for the report from Prof. Fabry. A month later the Registrar received a report from Prof. Fabry and informed Prof. Raman of its contents. Then Prof. Raman went to the Registrar's office and wrote a report in his own handwriting in which he stated that the three external Examiners had sent detailed reports recommending strongly that the candidate should be admitted to the degree* and he agreed thoroughly with them. So I was admitted to the D.Sc. degree in 1933.

A few months later we learnt that Prof. Raman had been offered the post of Director of the Indian Institute of Science at Bangalore. We were mortified to get this news and I personally discussed the matter with Prof. Raman in presence of Lady Raman and pointed out that his research work might suffer if he would leave such an organised laboratory with its experienced research workers. He, however, stated that the climate of Bangalore was far superior to that of Calcutta and the difference in the salaries at the two places was very large Prof. Raman was given an increment of Rs. 500/- per month after the award of the Nobel prize to him and he was drawing altogether Rs. 1500/- per month at that time. The salary offered to him at Bangalore was about double this amount. He told me that he would take one year's leave without pay and during that period the work in the Association would continue undisturbed. He also asked me to take charge of the instruments and apparatus belonging to the Palit Laboratory including those shifted to the laboratories of Association during his absence. I continued my work at the Association for about a year and after the expiry of his leave Prof. Raman came to Calcutta to hand over the charge. He, however, asked me to hand over the charge personally to the Registrar and the Secretary to the Council of Post-Graduate Teaching in Science. This task was easy for me, because the stock book had earlier been checked by a Special Officer appointed by the University. I took care to preserve the instruments which had been either damaged or broken during use in the laboratory including a Philips sealed X-ray tube which had been broken while a research scholar had been trying to use it for his work. This, not a single instrument was found missing. Thereafter Prof. Raman left for Bangalore, but before doing so he told me that he could offer me a post at Bangalore, but the salary would not be more than what was being drawn by me here. So, I thankfully declined the offer. Thus ended by long association with the most distinguished scientist of our country. It is quite clear from what has been narrated above that my contact with him brought about a vast change in my career and my indebtedness to him will be remembered till the last day of my life. □

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RAMAN AT IIS, BANGALORE—1933-48. REVIEW OF THE WORK DONE IN THE DEPARTMENT OF PHYSICS

R. S. KRISHNAN

THE Department of Physics at this Institute was formally inaugurated in April 1933 with Professor C. V. Raman as its Head and students were admitted in July 1933, most of them however having no previous experience of research. It took nearly a year to obtain possession of the laboratory accommodation and to provide the necessary fittings, furniture and equipment. The department was also handicapped by the very inadequate workshop facilities available at that time. In view of these difficulties, it was not till July 1934 that the department was in a position to commence serious research work, and not till July 1935 that it was moderately well-organized. It was during the period 1933-1936 the spade work for the future activities of the department was done and the foundations laid for an era of intense research work. Professor Raman continued to direct the activities of the Department till the year 1948. It is proposed to review the progress of the department during the period of Prof. Raman's stewardship (1933-1948). 491 original scientific papers were published from the Department in well-known periodicals; to summarise in a few paragraphs the contents of these papers is not an easy matter. In this summary it is only possible to discuss the more important contributions from the laboratory.

Molecular Scattering and Colloid Optics

A large number of studies have been made on the scattering of light by pure liquids and gases, binary liquid mixtures and by colloidal particles in suspension. The earlier studies resulted in the discovery by Dr. R. S. Krishnan of a perfectly general relation (known as the reciprocity relation) connecting the brightness and polarisation of the scattered light when the incident light is polarised in one or another of two perpendicular directions. Basing himself on this relation, he developed delicate optical methods to determine the polorisation characters of the scattered light, which culminated in the discovery of what has since been named as the "Krishnan effect". This term is used to denote the anomalous polarisation of the light transversely scattered by a substance when the incident light is polarised with its electric vector in the direction of observation. The effect has been attributed to the existence of particles or molecular aggregates whose size is not small compared with the wavelength of light. The effect is observed not only with colloids, but also by liquid mixtures near about the critical solution temperature and by optical glasses showing that they contain large aggregations of molecules. The effect has proved itself highly useful in the study of colloids, for by making quantitative measurements, it is possible to draw inferences regarding the structure, shape and size of the colloidal particles.

Ultrasonics and Hypersonics

A significant contribution to the field of ultrasonics has been made by Sir C. V. Raman and Dr. N. S. Nagendra Nath by their theory of the diffraction of light by ultrasonic waves. The theory is based on the simple idea that the light in passing through the field of ultrasonic waves suffers changes of phase in proportion to the amplitudes of the sound waves. The theory is found to give quantitative explanations of practically all the phenomena observed both in this laboratory and elsewhere. A complete generalisation of the theory has also been given which explains certain phenomena not explained by the elementary theory, such as the "reflection" of light by the ultrasonic waves. Various results to be anticipated on this theory, such as the effect of oblique incidence, diffraction by superimposed waves and the periodic visibility of the diffraction effects have been worked out and verified by other workers in the laboratory.

A large amount of work has also been done on the determination of ultrasonic velocities in more than a hundred organic liquids and also the dispersion of the velocities in the acoustic spectrum.

In the Raman-Nath theory, it had been shown that the diffracted light must have a frequency different from the incident light, the frequency difference being that of the sound wave. This effect, although undetectable with ultrasonic waves, has been demonstrated with "hypersonic" waves *i.e.* the spontaneous high frequency acoustic waves of thermal origin present in liquids. These waves reflect the light waves, resulting in a change in frequency as in the Doppler effect. The alteration in the frequency has been demonstrated by studies made with a Fabry-Perot etalon, when two frequencies symmetrically displaced on either side of the incident frequency are observed. An interesting feature that is observed in these studies is the presence of an unmodified central line, which has been ascribed to the presence of molecular clusters.

Studies made on the frequency shifts in these experiments have made it possible to calculate the velocities of the hypersonic waves and thus to extend the dispersion data of acoustic velocity to this region. An interesting fact, discovered by Dr. C. S. Venkateswaran, is that the hypersonic velocity in the case of highly viscous liquids such as glycerine is appreciably higher than the sonic and ultrasonic velocities. This shows that such liquids exhibit appreciable rigidity at these high frequencies and pass over into the solid state.

The existence of sound waves of thermal origin in a solid has been demonstrated by Dr. R. S. Krishnan in a simple way. He has photographed the Doppler shifts of frequency due to the scattering of light by thermal waves in diamond and corundum. The success is mainly due to the fact that the velocity of sound in these crystals is large. The resulting Doppler displacements in the frequency of the λ 2536.5 radiation scattered transversely are large enough to be recorded directly without interferometric aid using a quartz spectrograph of moderate power.

Raman spectra

Numerous papers have been published from the department on the Raman spectra of organic and inorganic substances. These have led to a clearer understanding of the chemical structure of many of the compounds and also of the theory of the Raman effect. For example, we may mention the work of Dr. Ananthakrishnan on cyclopropane and of Dr. C. S. Venkateswaran on ions of the type AB_3. Very interesting work has been done on the origin of wings in the spectrum of the scattered light in liquids and also of very low frequency lines in crystals. These have been attributed to the hindered rotation of the molecules in the liquid, and to the flexural oscillation in the solid. On melting the discrete lines are changed into wings, which become broader on raising the temperature, Dr. B. D. Saxena has theoretically investigated the influence of the symmetry of the crystal on the polarisation characters of the Raman lines and investigations have been carried out on this subject by both him and others in the laboratory.

Crystal Physics

Sir C. V. Raman's new theory of the atomic vibrations in crystals has opened up a wide field of Research and the activities of the department in recent years have mainly been devoted to studies in crystal physics. According to Raman's theory, the vibration spectrum of a crystal lattice consists of a finite number of discrete frequencies, the modes of vibrations corresponding to these frequencies being such that equivalent atoms in neighbouring cells in the lattice vibrate either in the same or in opposite phases. The results of the theory have been worked out for a number of crystals having simple structures and the number of characteristic frequencies have been calculated, These have been verified by studies on their Raman spectra made by Dr. R. S. Krishnan using the specially developed technique of employing the 2537 A radiations of the quartz mercury lamp. Numerous crystals have been studied with the utmost thoroughness and a rich harvest of results obtained in every one of the cases investigated, viz., calcite, quartz, barytes, gypsum, fluorspar, corundum, topaz, diamond, rock-salt, sylvine, ammonium chloride and ammonium bromide. The results obtained by him in the case of diamond, rock-salt and ammonium halides afford a direct experimental verification of the predictions of the new theory of crystal dynamics viz., that the vibration spectra of crystals consist of a finite number of discrete frequencies. His results on diamond deserve special mention, since the lines in this case have been shown to remain sharp even under very high dispersion, thus proving that the vibration frequencies are highly monochromatic.

The theory of atomic vibrations in crystals has also been used to calculate the specific heat and thermal expansion of a number of crystals. The agreement with experiment of the calculated values is good over the whole range of temperatures.

Dynamic X-ray reflections in Crystals

As is well-known, the infra-red vibrations in a crystal can interact with visible or ultra-violet light, resulting in a change of frequency of the latter in the scattered light. A similar interaction of the lattice vibrations with X-rays was foreseen by Sir C. V. Raman and actually shown to occur by him and Dr. P. Nilakantan. The actual mechanism is, however, different with X-rays. The change in frequency of the X-rays is too small to be determined, but the interaction of X rays with the crystal lattice results in a tilting of the reflecting planes of the crystal, and thus giving rise to new 'dynamic reflections' in directions away from the

Laue reflections. Such dynamic reflections have been observed with a large variety of crystals. The investigations with diamond support the theory particularly well. It has been suggested by other workers in the field that the extra reflections are not due to the infra-red vibrations but to the presence of elastic waves of low frequency. That this is not so has been proved by the sharpness and specular nature of the reflections and also by the fact that the positions of the dynamic reflections can be quantitatively accounted for by the theory.

The Physics of the Diamond

From the very beginning, investigations have been made on the structure and properties of diamond. In 1934, Dr Nagendra Nath made studies on the lattice structure of diamond and gave the correct interpretation of the vibration of frequency 1332 cm^{-1}. As a result of the acquisition of a collection of diamonds made by Sir C. V. Raman, an impetus was given to researches to this branch since 1941. A large variety of properties of diamonds have been investigated and many new results have been obtained. The most interesting result that has emerged from these studies is the fact that diamonds show large variations in its properties from specimen to specimen, which must be attributed to inherent variations in its structure and not to the presence of any extraneous impurities. The interpretation of this fact remained obscure until Sir C. V. Raman put forward his theory of the structure of diamond. The internal structure of diamond is based on two interpenetrating face centred lattices of carbon atoms. According to Raman, these tetrahedra can point either way, so that there are 2×2 or four possible forms of diamond, two of which have tetrahedral and the other two, octahedral symmetry. In any actual specimen. these four structures can occur side by side or intermingled with each other and it is the variations in the nature and extent of the interpenetrations of the different structures that gives rise to the variations in the physical properties of diamond. A natural result of this theory is that the variations of different physical properties such as fluorescence, infrared absorption and X-ray reflecting power must be definitely correlated to one another, and this has been definitely proved to be the case. Experimental evidence has also been forthcoming for the actual existence of the four varieties of diamond.

Miscellaneous

Among other investigations may be mentioned the studies made on Indian musical drums by Sir C. V. Raman. These have been shown to be a practical solution of the problem of obtaining circular membranes having harmonic overtones. The colours of the plumage of birds and of iridescent shells have formed the subject of other studies. Magnetic studies on crystals, investigations on the dielectric behaviour of liquids and gases, studies of fluorescence and other aspects of spectroscopy form some of the other topics that have engaged the attention of workers in the laboratory. ☐

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PRESENTATION SPEECH BY PROFESSOR H. PLEIJEL, CHAIRMAN OF THE NOBEL COMMITTEE FOR PHYSICS OF THE ROYAL SWEDISH ACADEMY OF SCIENCES

Your Majesty, Your Royal Highnesses,
Ladies and Gentlemen,

The Academy of Sciences has resolved to award the Nobel Prize in Physics for 1930 to Sir Venkata Raman for his work on the scattering of light and for the discovery of the effect named after him.

The diffusion of light is an optical phenomenon, which has been known for a long time. A ray of light is not perceptible unless it strikes the eye directly. If, however, a bundle of rays of light traverses a medium in which extremely fine dust is present, the ray of light will scatter to the sides and the path of the ray through the medium will be discernible from the side. We can represent the course of events in this way ; the small particles of dust begin to oscillate owing to electric influence from the ray of light, and they form centres from which light is disseminated in all directions. The wavelength, or the number of oscillations per second, in the light, thus diffused is here the same as in the original ray of light. But this effect has different degrees of strength for light with different wavelengths. It is stronger for the short wavelengths than for the long ones, and consequently it is stronger for the blue part of the spectrum than for the red part. Hence if a ray of light containing all the colours of the spectrum passes through a medium, the yellow and the red rays will pass through the medium without appreciable scattering, whereas the blue rays will be scattered to the sides. This effect has received the name of the Tyndall effect.

Lord Rayleigh, who has made a study of this effect, has put forward the hypothesis that the blue colours of the sky and the reddish colouring that is observed at sunrise and sunset are caused by the diffusion of light owing to the fine dust or the particles of water in the atmosphere. The blue light from the sky would thus be light scattered to the sides, while the reddish light would be light that passes through the lower layers of the atmosphere and which has become impoverished in blue rays owing to scattering. Later, in 1899, Rayleigh threw out the suggestion that the phenomenon in question might be due to the fact that the molecules of air themselves exercised a scattering effect on the rays of light.

In 1914 Cabannes succeeded in showing experimentally that pure and dustless gases also have the capacity of scattering rays of light.

But a closer examination of scattering in different substances in solid, liquid, or gaseous form showed that the scattered light did not in certain respects exactly follow the laws which, according to calculation, should hold good for the Tyndall effect. The hypothesis which formed the basis of the effect would seem to involve amongs other things, that the rays scattered to the sides were polarized. This, however, did not prove to be exactly the case.

This divergence from what was to be expected was made the starting-point of a searching study of the nature of scattered light, in which study Raman was one of those who took an active part. Raman sought to find the explanation of the anomalies in symmetry observed in the molecules. During these studies of his in the phenomenon of scattering, Raman made, in 1928, the unexpected and highly surprising discovery that the scattered light showed not only the radiation that derived from the primary light but also a radiation that contained other wavelengths, which were foreign to the primary light.

In order to study more closely the properties of the new rays, the primary light that was emitted from a powerful mercury lamp was filtered in such a way as to yield a primary light of one single wavelength. The light scattered from that ray in a medium was watched in a spectrograph, in which every wavelength or frequency produced a line. Here he found that, in addition to the mercury line chosen, there was obtained a spectrum of new sharp lines, which appeared in the spectrograph on either side of the original line. When another mercury line was employed, the same extra spectrum showed itself round it. Thus, when the primary light was moved, the new spectrum followed in such a way that the frequency distance between the primary line and the new lines always remained the same.

Raman investigated the universal character of the phenomenon by using a large number of substances as a scattering medium, and everywhere found the same effect.

The explanation of this phenomenon, which has received the name of the Raman effect, after its discoverer, has been found by Raman himself, with the help of the modern conception of the nature of light. According to that conception, light cannot be emitted from or absorbed by material otherwise than in the form of definite amounts of energy or what are known as light quanta. Thus the energy of light would possess a kind of atomic character. A quantum of light is proportionate to the frequency of rays of light, so that in the case of a frequency twice as great, the quanta of the rays of light will also be twice as great.

In order to illustrate the conditions when an atom emits or absorbs light energy, we can, according to Bohr, picture to ourselves the atom as consisting of a nucleus, charged with positive electricity round which negative electrons rotate in circular paths at various distances from the centre. The path of every such electron possesses a certain energy, which is different for different distances from the central body.

Only certain paths are stable. When the electron moves in such a path, no energy is emitted. When, on the other an electron falls from a path with higher energy to one with lower energy—that is to say, from an outer path to an inner path light is emitted with a frequency that is characteristic of these two paths and the energy of radiation consists of a quantum of light. Thus the atom can give rise to as many frequencies as the number of different transitions between the stable paths. There is a line in the spectrum corresponding to each frequency.

An incoming radiation cannot be absorbed by the atom unless its light quantum is identical with one of the light quanta that the atom can emit.

Now the Raman effect seems to conflict with this law. The positions of the Raman lines in the spectrum do not correspond, in point of fact, with the frequencies of the atom itself, and they move with the activating ray. Raman has explained this apparent contradiction and the coming into existence of the lines by the effect of combination between the quantum of light coming from without and the quanta of light that are released or bound in the atom. If the atom, at the same time as it receives from without a quantum of light, emits a quantum of light of a different magnitude, and if the difference between these two quanta is identical with the quantum of light which is bound or released when an electron passes from one path to another, the quantum of light coming from without is absorbed. In that case, the atom will emit an extra frequency, which either will be the sum of or the difference between the activating ray and a frequency in the atom itself. In this case, these new lines group themselves round the incoming primary frequency on either side of it, and the distance between the activating frequency and the nearest Raman lines will be identical with the lowest oscillation frequencies of the atom or with its ultrared spectrum. What has been said as to the atom and its oscillations also holds good for the molecule.

In this way, we get the ultrared spectrum moved up to the spectral line of the activating light. The discovery of the Raman lines has proved to be of extraordinarily great importance for our knowledge of the structure of molecules.

So far, indeed, there have been all but insuperable difficulties in the way of studying these ultrared oscillations, because that part of the spectrum lies so far away from the region where the photographic plate is sensitive. Raman's discovery has now overcome these difficulties, and the way has been opened for the investigation of the oscillations of the nucleus of the molecules. We choose the primary ray within that range of frequency where the photographic plate is sensitive. The ultrared spectrum, in the form of the Raman lines, is moved up to that region and, in consequence of that, exact measurements of its lines can be effected.

In the same way, the ultraviolet spectrum can be investigated with the help of the Raman effect. Thus we have obtained a simple and exact method for the investigation of the entire sphere of oscillation of the molecules.

Raman himself and his fellow-workers have, during the years that have elapsed since the discovery was made, investigated the frequencies in a large number of substances in the solid, liquid, and gaseous state. Investigations have been made as to whether different conditions of aggregation affect atoms and molecules, and the molecules conditions in electrolytic dissociation and the ultrared absorption spectrum of crystals have been studied.

Thus the Raman effect has already yielded important results concerning the chemical constitution of substances ; and it is to foresee that the extremely valuable tool that the Raman effect has placed in our hands will in the immediate future bring with it a deepening of our knowledge of the structure of matter.

Sir Venkata Raman, the Royal Academy of Sciences has awarded you the Nobel Prize in Physics for your eminent researches on the diffusion of gases and for your discovery of the effect that bears your name. The Raman effect has opened new routes to our knowledge of the structure of matter and has already given most important results.

I now ask you to receive the prize from the hands of His Majesty.

THE MOLECULAR SCATTERING OF LIGHT

Nobel Lecture by C. V. Raman

(at Stockholm on December 11, 1930)

The colour of the sea

In the history of science, we often find that the study of some natural phenomenon has been the starting point in the development of a new branch of knowledge. We have an instance of this in the colour of skylight, which has inspired numerous optical investigations, and the explanation of which, proposed by the late Lord Rayleigh, and subsequently verified by observation, forms beginning of our knowledge of the subject of this lecture. Even more striking, though not so familiar to all, is the colour exhibited by oceanic waters. A voyage to Europe in the summer of 1921 gave me the first opportunity of observing the wonderful blue opalescence of the Mediterranean Sea. It seemed not unlikely that the phenomenon owed its origin to the scattering of sunlight by the molecules of the water. To test this explanation, it appeared desirable to ascertain the laws governing the diffusion of light in liquids, and experiments with this object were started immediately on my return to Calcutta in September, 1921. It soon became evident, however, that the subject possessed a significance extending far beyond the special purpose for which the work was undertaken, and that it offered unlimited scope for research. It seemed indeed that the study of light-scattering might carry one into the deepest problems of physics and chemistry, and it was this belief which led to the subject becoming the main theme of our activities at Calcutta from that time onwards.

The theory of fluctuations

From the work of the first few months, it became clear that the molecular scattering of light was a very general phenomenon which could be studied not only in gases and vapours but also in liquids and in crystalline and amorphous solids, and that it was primarily an effect arising from molecular disarray in the medium and consequent local fluctuations in its optical density. Except in amorphous solids, such molecular disarray could presumably be ascribed to thermal agitation, and the experimental results appeared to support this view. The fact that molecules are optically anisotropic and can orientate freely in liquids was found to give rise to an additional type of scattering. This could be distinguished from the scattering due to fluctuations in density by reason of its being practically unpolarized, whereas the latter was completely polarized in the transverse direction. The whole subject was critically reviewed and the results till then obtained were set out in an essay published by the Calcutta University Press in February 1922.

The various problems requiring solution indicated in this essay were investigated with the aid of a succession of able collaborators. It is possible to mention briefly only a few of the numerous investigations which were carried out at Calcutta during the six years from 1922 to 1927. The scattering of light in fluids was studied by Ramanathan over a wide range of pressures and temperatures with results which appeared to support the fluctuation theory of its origin. His work also disclosed the remarkable changes in the state of polarization which accompany the variations of intensity with temperature in vapours and in liquids. Liquid mixtures were investigated by Kameswara Rao, and furnished optical proof of the existence in such systems of simultaneous fluctuations of density, composition, and molecular orientation. Srivastava studied the scattering of light in crystals in relation to the thermal fluctuations of density and their increase with temperature. Ramdas investigated the scattering of light by liquid surfaces due to thermal agitation, and established a relation between surface-tension and surface-opalescence. He also traced the transition from surface-opalescence to volume-opalescence which occurs at the critical temperature. Sogani investigated X-ray diffraction in liquids, in order to connect it with their optical behaviour, and test the application of the fluctuation theory to X-ray scattering.

The anisotropy of molecules

As stated above, the state of polarization of the light scattered in fluids is connected with the optical anisotropy of the molecules. Much of the work done at Calcutta during the years from 1922 to 1927 was intended to obtain data concerning this property and to establish its relations with various optical phenomena. Krishnan examined a great many liquids, and by his work showed very clearly the dependence of the optical anisotropy of the molecule on its chemical constitution. Ramakrishna Rao studied the depolarization of scattered light in a very large number of gases and vapours and obtained information of high importance for the progress of the subject. Venkateswaran studied the scattering of light in aqueous solutions to find the influence on it of electrolytic dissociation. Ramachandra Rao investigated liquids having highly elongated molecules and also highly polar substances over a wide range of temperatures, and discovered the influence of molecular shape and molecular association on the depolarization of scattered light in liquids.

The interpretation of the observations with liquids involved the development of a molecular theory of light-scattering in dense media which was undertaken by Ramanathan, I myself, and Krishnan. A revised opalescence formula was derived which differed from that of Einstein and yielded results in better agreement with observation. Krishnan and I also published a series of investigations showing how the optical anisotropy of the molecules deduced from light-scattering could be utilized to interpret the optical and dielectric behaviour of fluids, and also the electric, magnetic, and mechanical birefringence exhibited by them. The conclusions derived from these studies enabled a connection to be established between the molecular anisotropy observed in fluids and the optical, electric, and magnetic aeolotropy exhibuted by solids in the crystalline state.

A new phenomenon

The investigations referred to above were in the main guided by the classical electromagnetic theory of light, the application of which to the problems of light-scattering is chiefly associated with the names of Rayleigh and Einstein. Nevertheless, the possibility that the corpuscular nature of light might come into evidence in scattering was not overlooked and was in fact elaborately discussed in the essay of February 1922 which was published at least a year before the well-known discoveries of Compton on X-ray scattering. While our experiments in the main appeared to support the electromagnetic theory of light, evidence came to hand at a very early stage of the investigations of the existence of a phenomenon which seemed to stand outside the classical scheme of thought. The scattering of light in transparent fluids is extremely feeble, much weaker in fact than the Tyndall effect usually observed in turbid media. It was experimentally discovered that associated with the Rayleigh-Einstein type of molecular scattering was another and still feebler type of secondary radiation, the intensity of which was of the order of the magnitude of a few hundredths of the classical scattering and differed from it in not having the same wavelength as the primary or incident radiation. The first observation of this phenomenon was made at Calcutta in April 1923 by Ramanathan who was led to it in attempting to explain why in certain liquids (water, ether, methyl and ethyl alcohols), the depolarization of scattered light varied with the wavelength of the incident radiation. Ramanathan found that after exhaustive chemical purification and repeated slow distillation of the liquid in vacuum, the new radiation persisted undiminished in intensity, showing that it was a characteristic property of the substance studied and not due to any fluorescent impurity. Krishnan observed a similar effect in many other liquids in 1924, and a some-what more conspicuous phenomenon was observed by me in ice and in optical glasses.

The optical analogue of the Compton effect

The origin of this puzzling phenomenon naturally interested us, and in the summer of 1925, Venkateswaran attempted to investigate it by photographing the spectrum of the scattered light from liquids, using sunlight filtered through colour screens, but was unable to report any decisive results. Ramakrishna Rao in his studies on the depolarization of scattering during 1926 and 1927 looked carefully for a similar phenomenon in gases and vapours, but without success. This problem was taken up again by Krishnan towards the end of 1927. While his work was in progress, the first indication of the true nature of the phenomenon came to hand from a different quarter. One of the problems interesting us at this time was the behaviour in light-scattering of highly viscous organic liquids which were capable of passing over into the glassy state. Venkateswaran undertook to study this question, and reported the highly interesting result that the colour of sunlight scattered in a highly purified sample of glycerine was a brilliant green instead of the usual blue. The phenomenon appeared to be similar to that discovered by Ramanathan in water and the alcohols, but of much greater intensity, and therefore, more easily studied. No time was lost in following up the matter. Tests were made with a series of filters transmitting narrow regions of the solar spectrum and placed in the path of the incident beam, which showed that in every case the colour of the scattered light was different from that of the incident light, and was displaced from it towards the red. The radiations were also strongly polarized. These facts indicated a clear analogy between the empirical characters of the phenomenon and the Compton effect. The work of Compton had made familiar the idea that the wavelength of radiation could be degraded in the process of scattering and the observations with glycerine suggested to me that the phenomenon which had puzzled us ever since 1923 was in fact the optical analogue of the Compton effect. This idea naturally stimulated further investigation with other substances.

The chief difficulty which had hitherto oppressed us in the study of the new phenomenon was its extreme feebleness in general. This was overcome by using a 7-inch refracting telescope in combination with a short-focus lens to condense sunlight into a pencil of very great intensity. With these arrangements and using complementary light-filters in the path of the incident and scattered beams, as was done by Ramanathan in 1923 to isolate the modified radiations, it was found that they could be readily observed in a great many liquids, and that in many cases they were strongly polarized. Krishnan, who very materially assisted me in these investigations, found at the same time that the phenomenon could be observed in several organic vapours, and even succeeded in visually determining the state of polarization of the modified radiations from them. Compressed gases such as CO_2 and N_2O, crystalline ice, and optical glasses also were found to exhibit the modified radiations. These observations left little doubt that the phenomenon was really a species of light-scattering analogous to the Compton effect.

The spectroscopic character of the new effect

Thanks to the vastly more powerful illumination made available by the 7-inch refractor, the spectroscopic examination of the effect, which had been abandoned in 1925 as indecisive now came within the reach of direct visual study. With a Zeiss cobalt-glass filter placed in the path of the incident beam and one or other of a series of organic liquids as the scattering substance, a band in the blue-green region was observed by me in the spectrum of the scattered light, separated by a dark interval from the indigo-violet region transmitted by the filter. Both of these regions in the spectrum became sharper when the region of transmission was narrowed by insertion of an additional filter in the incident beam. This suggested the employment, instead of sunlight, of the highly monochromatic radiations given out by a mercury arc in combination with a condenser of large aperture and a cobalt-glass filter. With these arrangements, the spectrum of the scattered light from a variety of liquids and solids was visually examined, and the startling observation was made that the spectrum generally included a number of sharp lines or bands on a diffuse background which were not present in the light of the mercury arc.

The quartz mercury lamp was so powerful and convenient a source of monochromatic illumination that, at least in the case of lqiuids and solids, photographing the spectrum of scattered light was found to present no extraordinary difficulties. The earliest pictures of the phenomenon were in fact taken with a portable quartz spectrograph of the smallest size made by the firm of Hilger. With a somewhat larger instrument of the same type, Krishnan obtained very satisfactory spectrograms with liquids and with crystals on which measurements of the desired precision could be made, and on which the presence of lines displaced towards the violet was first definitely established. The experimental difficulties were naturally greater in the case of gases or vapours, though they could be lessened by working with the substance under pressure. With an improvised instrument of a large aperture (F/1.8), Ramdas obtained the first spectrograms with a gaseous substance (ether vapour) at atmospheric pressure.

In interpreting the observed phenomena, the analogy with the Compton effect was adopted as the guiding principle. The work of Compton had gained general acceptance for the idea that the scattering of radiation is a unitary process in which the conservation principles hold good. Accepting this idea, it follows at once that, if the scattering particle gains any energy during the encounter with the quantum, the latter is deprived of energy to the same extent, and accordingly appears after scattering as a radiation of diminished frequency. From thermodynamic principles, it follows that the reverse process should also be possible. Adopting these ideas, the actual observations could be interpreted, and the agreement of the observed displacements with the infrared frequencies of the molecules made it clear that the new method opened up an illimitable field of experimental research in the study of the structure of matter.

Interpretation of the effect

It appears desirable to emphasize that the conservation principle of Compton is useful in interpreting the effects disclosed by experiment ; it is by itself insufficient to explain the observed phenomena. As is well known from studies on molecular spectra, a gaseous molecule has four different species of energy of increasing orders of magnitude, namely, those corresponding to translatory motion, rotation, vibration, and electronic excitation. Each of these, except the first, is quantized and may be represented by an integer is an extended sequence of quantum numbers, The aggregate energy of a molecule may, therefore, assume any one out of a very large number of possible values. If we assume that an exchange of energy occurs in the collision between the molecule and the quantum, and limit ourselves to cases in which the final energy of the molecule is less than that of the incident quantum, we arrive at the result that the spectrum of the scattered light should contain an immense number of new lines and should in fact rival in its complexity the band spectrum of the molecule observed in the emission or absorption of light. Nothing more different from what is actually observed can be imagined than the foregoing picture. The most conspicuous feature revealed by experiment is the beautiful simplicity of the spectra of even complicated poly-atomic molecules obtained in light-scattering, a simplicity that is in striking contrast to the extreme complexity of their emission or absorption spectra. It is this simplicity that gives to the study of light-scattering its special significance and value. It is clear that the effect actually observed was not and could not have been foreseen from an application of the conservation principles.

The general principle of correspondensce between the quantum and classical theories enunciated by Niels Bohr enables us, on the other hand, to obtain a real insight into the actual phenomena. The classical theory of light-scattering tells us that if a molecule scatters light while it is moving, rotating or vibrating, the scattered radiations may include certain frequencies, different from those of the incident waves. This classical picture, in many respects, is surprisingly like what we actually observe in the experiments. It explains why the frequency shifts observed fall into three classes, translational, rotational, and vibrational, of different orders of magnitude. It explains the observed selection rules, as, for instance, why the frequencies of vibration deduced from scattered light include only the fundamentals and not the overtones and combinations which are so conspicuous in emission and absorption spectra. The classical theory can even go further and give us a rough indication of the intensity and polarization of the radiations of altered frequency. Nevertheless, the classical picture has to be modified in essential respects to give even a qualitative description of the phenomena, and we have, therefore, to invoke the aid of quantum principles. The work of Kramers and Heisenberg and the newer developments in quantum mechanics which have their root in Bohr's correspondence principle seem to offer a promising way of approach towards an understanding of the experimental results. But until we know much more than we do at present regarding the structure of molecules, and have sufficient quantitative experimental knowledge of the effect, it would be rash to suggest that they afford a complete explanation of it.

The significance of the effect

The universality of the phenomenon, the convenience of the experimental technique and the simplicity of the spectra obtained enable the effect to be used as an experimental aid to the solution of a wide range of problems in physics and chemistry. Indeed, it may be said that it is this fact which constitutes the principal significance of the effect. The frequency differences determined from the spectra, the width and character of the lines appearing in them, and the intensity and state of polarization of the scattered radiations enable us to obtain an insight into the ultimate structure of the scattering substance. As experimental research has shown, these features in the spectra are very definitely influenced by physical conditions, such as temperature and state of aggregation, by physico-chemical conditions, such as mixture, solution, molecular association and polymerization, and most essentially by chemical constitution. It follows that the new field of spectroscopy has practically unrestricted scope in the study of problems relating to the structure of matter. We may also hope that it will lead us to a fuller understanding of the nature of light, and of the interactions between matter and light.

Some concluding remarks

From a physical point of view, the quantitative study of the effect with the simplest molecules holds out the largest hope of fundamental advances. The beautiful work of McLennan with liquefied gases, and that of R. W. Wood and Rasetti are pioneer investigations in this field which command the highest admiration. The quantitative study of the effect with crystals of the simplest possible chemical constitution is naturally of great importance. The case of the diamond, which has been investigated by Ramaswamy, Robertson, and Fox and with especial completeness by Bhagavantam, is of special interest. Very surprising results have been obtained with this substance, which may be the pathway to a fuller understanding of the nature of the crystalline state. I should also like to draw attention to the work of Krishnamurti, who has traced a remarkable dependence of the intensity of the spectral lines observed in scattering on the nature of the chemical bond, and followed the transition from the homopolar to the heteropolar type of chemical combination. Krishnamurti's observation that the paramagnetism of crystals apparently influences the observed intensity of the displaced lines is one of the most remarkable ever made in this new field of research. ☐

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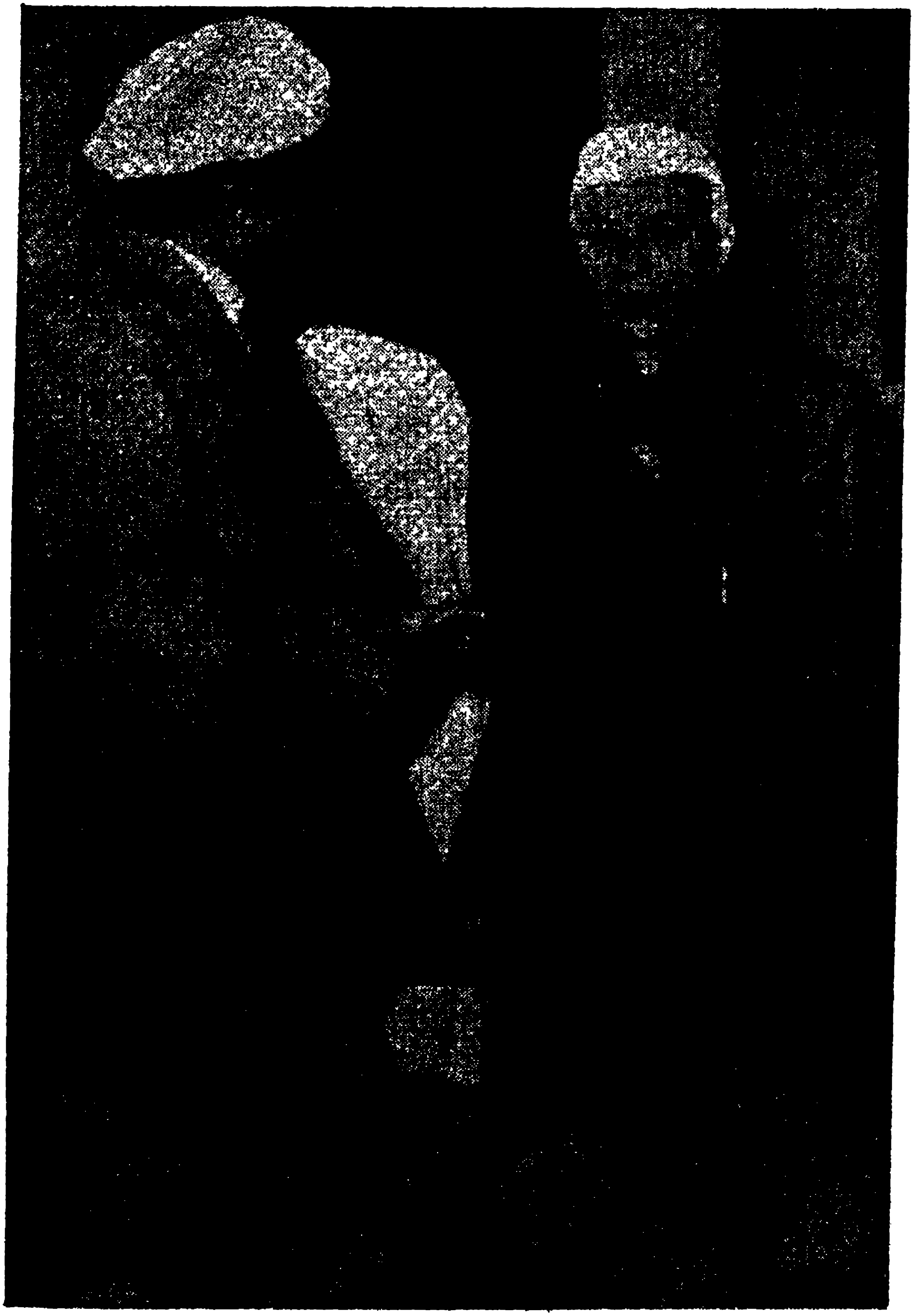

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MAJOR EVENTS IN THE LIFE OF RAMAN

Year	Events
1888 Nov. 7	Born at Tiruchirapalli (Trichinopoly) in Tamil Nadu (then Madras State).
1900	Matriculated with first position, from Hindu High School at Vishakhapatnam.
1902	Passed Intermediate examination from Hindu College, Vishakhapatnam.
1903	Joined Presidency College, Madras, for B A. in Physics.
1905	Got B.A. degree at the age of 16 years, standing first, receiving the university Gold Medal for Physics, Elphinstone Medal & Jagirdar Memorial Gold Medal.
	Joined M.A. classes in Physics.
1906	Published his first paper in *Philosophical Magazine* of England at the age of 18 years.
1907	Selected in the competitive examination for recruitment to the Indian Finance Department, standing first.
	Married Lokasundari, a girl of his own choice.
	Appointed Assistant Accountant General at Calcutta.
	Started research at the Indian Association for the Cultivation of Science, Calcutta.
1910	Transferred to Rangoon and after a spell of leave taken due to the sickness of his father, posted at Nagpur.
1911	Posted, on promotion, at Calcutta.
1912	Awarded Curzon Research Prize.
1913	Asutosh Mookerjee persuaded the Palit Board to offer Palit Professorship in Physics to Raman, then 25 years.
	Chairman, Physics section of the Science Congress.
	Awarded Woodburn Research Medal.
1914	Lectured at the Madras University.
1917	Left Finance Department and joined Calcutta University as Palit Professor in Physics.
1919	Elected Secretary of the Indian Association for the Cultivation of Science.
1921	Went as delegate of Calcutta University to the Congress of the Universities of the British Empire held at Oxford.
	Met J. J. Thomson, Rutherford, and other British physicists.
	Started studies on the scattering of light.
1922	Awarded Honorary degree of D.Sc. by Calcutta University.
	Visiting Professor at Madras University.
1923	Frequency (colour) change in light due to scattering first observed by Ramanathan, a pupil of Raman, but the observation was not understood.
1924	Visited Canda and opened a symposium on the scattering of light in Toronto.

		Attended Franklin centenary celebrations in Philadelphia.
		Elected *fellow of the Royal Society of London*.
		Helped start *Indian Journal of Physics* of which he was the first editor.
1924-25		Visiting Professor at the California Institute of Technology, at the invitation of Prof. R. A. Millikan.
1925		Visited Russia at the invitation of the Russian Academy of Sciences, for its bicentenary celebrations.
		Lectured at the Mendeleyev Congress.
1926		Delivered the convocation address at Banaras Hindu University.
1927		Published 155-page article entitled *Musikin-stumente und ihre Klange*, in *Handbuch der Physik*, as a result of a special invitation.
1928	Feb. 16	Sent a communication, written jointly with K. S. Krishnan, on the discovery of the effect (now bearing Raman's name) to the London journal, *Nature*. Published on 31st March, 1928.
	Feb. 28	Raman announced the discovery publicly.
	March 8	Another letter sent to *Nature* (by Raman only).
	Mar. 16	Delivered an address at Bangalore to the South Indian Science Association on the "new radiation". (Published in April-May issue of the *Indian Journal of Physics*). On return to Calcutta, the address was printed overnight and thousands of reprints were distributed to scientists all over the world on 31. 3. 1928.
	Mar. 22	Sent still another letter jointly with Krishnan to *Nature* on the new discovery. A spectrogram showing the displaced Raman lines published for the first time.
	May 7	Paper on the discovery received for publication in the *Indian Journal of Physics* (written jointly with Krishnan).
	Aug. 7	Sent a long paper jointly with Krishnnan for publication in the *Proceedings of the Royal Society of London*. Published in the January, 1929 issue.
		Awarded *Matteucci* Medal by the Italian Society of Science.
1929	June 3	Knighted by King Emperor George V of England.
		Invited by Faraday Society to open a discussion on Molecular Spectra and Structure, at Bristol.
		General President of the Indian Science Congress.
		Received honorary degree of Ph.D. from Freiburg University.
		Received honorary membership of the Physical Society of Zurich.
		Awarded Hughes Medal of the Royal Society of London.
1930		Awarded Nobel Prize in Physics.
1932		Conferred honorary D.Sc. degree of the University of Paris.
1933		Left Calcutta for the Indian Institute of Science at Bangalore, more or less unceremoniously, to become its first Indian Director.
1934		Founded the Indian Academy of Sciences on 24 April 1934.
1935		Maharaja of Mysore gifted land to Raman for establishing research institute.
		First annual meeting of the Indian Academy of Sciences held

	at Bombay, In his presidential address Raman paid tribute to Jamsetjee Tata for propagating science and creating a local scientific culture.
1936	Met Mahatma Gandhi. (Raman greatly admired Gandhi and Tagore.)
1937	Raman forced to step down from the Director's post to professorship of physics at the Indian Institute of Science.
	Attended International Congress of Physics in Europe.
1941	Awarded Franklin Medal by the Franklin Institute, Philadelphia.
	Elected member of the Optical Society of America.
	Held symposia on the physical properties of diamond.
	Gave Gaekwar Foundation lectures on physical optics, published later in 1959.
1948	Attended an international conference on "Diffusion Moleculaire de la Lumiere et la Effect Raman" at Bardeaux in France, where an honorary doctorate was conferred on him.
	Attended an international Congress on Crystallography at Harvard, USA.
1949	Raman assumed charge of the Raman Research Institute at Bangalore at the age of 61.
	Appointed National Professor by the Government of India, the first to be so honoured.
	Elected Foreign Associate of the Academy of Sciences of France in succession to the mathematician G.H. Hardy.
1951	Organised a symposium on Thunderstorms. Raman took much interest in meteorology in later years. A number of his students had joined the Indian Meteorological Department, the only Government Department where physicists could be employed then in some numbers.
1954	On Republic Day was conferred the highest honour, Bharat Ratna
	Received the International Lenin Award.
1957	Elected Foreign Member of the Soviet Academy of Sciences.
1961	Appointed member of the Pontifical Academy of Sciences by Pope John XXIII.
1964	Conferred honorary degree of D.Sc. by the University of Delhi.
1959-67	Wrote a number of papers on the physiology of vision, published in book-form in 1968. It cannot be called a great work, although Raman set great store by it.
1968	Sent resignation from the fellowship of the Royal Society of London, which he held for 44 years.
1970	Died in the early hours of morning on 21st November, at his official home in Bangalore, at the age of 82 years, leaving behind his wife and two sons. Cremated in the premises of the Raman Institute in accordance with his wishes.

NOTES & NEWS

C. V. Raman's attitude to science

The Indian Academy of Sciences, Bangalore, the sponsoring body of the C. V. Raman centenary celebrations, concluded its two-day 54th annual meeting at Calcutta.

In his presidential address, Prof. Obaid Siddiqui of the Tata Institute of Fundamental Research (TIFR) spoke about the late C. V. Raman's views and attitude towards science.

Presenting a perspective on Raman from today's standpoint, he said that Raman pursued science for the sake of science, an attitude which may not be possible to wholly sustain to-day when science is being increasingly driven by technology and societal needs.

To-day's scientist is in a state of dilemma which stems from the dichotomy of approach to science—to do science for society or science for its own sake.

Prof. Siddiqui referred to Raman's disinclination towards Jawaharlal Nehru and S. S. Bhatnagar's model of organised science that links itself to the development process of a developing country.

A developing country needs technology, he said, it is forced to look for it elsewhere if it does not emerge from its own scientists.

Prof. Siddiqui had no solution to offer for the dilemma faced by to-day's scientists.

Though many of the scientists agreed with his balanced and unbiased apprisal of Raman those who were close to the Nobel Laureate seemed to be perturbed by Prof. Siddiqui's remarks. This was reflected in the concluding lecture by Prof. S. Chandrasekhar of the Raman Research Institute, Bangalore, who talked on "Recent developments in the physics of liquid crystals". Prof. Chandrasekhar dwelt on the optical properties of liquid crystals that would have attracted Raman.

"Science was Raman's *raison d'etre*" Prof. Chandrasekhar observed. For him, he said, "inspiration came entirely from within. He did not have anyone to guide him". Till he died, his passion for science remained undiminished, he said. He referred to an incident when Nehru called him to Delhi and offered him the highest scientific post, but Raman had declined it saying, "I have promises to keep". He was in his sixties then and continued to do research. ☐

The Hindu

Our major failure is education : Rajiv

The Prime Minister, Mr. Rajiv Gandhi, came down heavily on the system of education being pursued in the country. Inaugurating the C. V. Raman centenary celebrations at the Indian Association for the Cultivation of Science in Calcutta on Wednesday, Mr. Gandhi almost helplessly admitted that one of our major "failures" in the post-Independence period has been in the sphere of education. He said that no doubt there had been "quantitative expansion" but it has been accompanied by a "qualitative deterioration".

The Indian Academy of Sciences, the Indian National Science Academy and the Indian Association for the Cultivation of Science are jointly organizing the country-wide celebrations that was inaugurated in Calcutta on Wednesday. The Nobel Laureate had worked in a laboratory at the Indian Association for the Cultivation of Science in the early years of this century where he discovered his famous "Raman Effect".

"INITIATIVE KILLED"

Mr. Gandhi said that our education system was such that it "killed all initiative in children" ; it "destroyed imagination" and it "imprisoned the young minds" in "dull discipline and classroom routine". He said that our failure lay in being unable to "expand and direct our efforts" in the sphere of education visualized by men like Raman.

The Prime Minister felt that the way science was taught in classrooms made little sense. He emphasized on the "combination of encouraging the scientific spirit and creating the proper work atmosphere" at the school and college levels.

"It is ironic that more applications of Raman's theories had been done in the West" than in the scientist's own country, the Prime Minister pointed out. He stressed the importance of "linking the laboratory with the welfare of the people". He said that he was aware that Raman "deplored" the linkage of laboratory and industry but, differing with Raman in this one aspect, Mr. Gandhi went on to add that the relationship between fundamental research and applied science would have to be promoted.

Mr. Gandhi said that leading scientists often felt that they would engage themselves in fundamental research work alone while application of the theories they propounded would be left in the hands of lesser colleagues. He criticized this attitude and reiterated that bonds would have to be strengthened between the "factory and the laboratory".

"RICH HERITAGE"

He said that science had flourished in India for almost 5,000 years now. He recalled the contribution of Aryabhatta and Varahamihira and felt that the scientific spirit was throttled with the stranglehold of the British in the 18th century. It was between December, 1887 and November, 1888, that two great scientists were born in India—Srinivasa Ramanujan* and C. V. Raman. Raman had learnt science by "keenly observing nature". Mr. Gandhi said and described him as the "one of the most remarkable Indians of modern times", who had "brought glory to India".

Speaking on the occasion, the West Bengal Governor, Mr. Nurul Hasan, said that Calcutta was a great centre of science at one period and pointed out that "Raman had proved there is no dichotomy between pure science and science for the welfare of mankind". Raman was against the proliferation of nuclear arms, he said.

Thirty-five scientists, including Dr. A. S. Basu, Dr. A. Bose, Dr S. Chandrasekhar, Dr. P. R. Iyenger, Dr. N. Jayaram, Dr. S. S. John, Dr. S. K. Joshi and Mr. R. Mukhopadhyay were awarded the Raman Centenary medals. The Prime Minister before giving away the medals, unveiled a bust of the scientist and released the book, Journey of Light—a biography of Raman and also the physicist's collected works. The Prime Minister dedicated to the nation a monument that would be erected at 210 Bowbazar Street, the premises, which had housed the association's office at the time when Raman was attached to it as a scientist. □

The Statesman

Letters to the editor

A New Type of Secondary Radiation*

If we assume that the X-ray scattering of the 'unmodified' type observed by Prof. Compton corresponds to the normal or average state of the atoms and molecules, while the 'modified' scattering of altered wave-length corresponds to their fluctuations from that state, it would follow that we should expect also in the case of ordinary light two types of scattering, one determined by the normal optical properties of the atoms or molecules, and another representing the effect of their fluctuations from their normal state. It accordingly becomes necessary to test whether this is actually the case. The experiments we have made have confirmed this anticipation, and shown that in every case in which light is scattered by the molecules in dust-free liquids or gases, the diffuse radiation of the ordinary kind, having the same wavelength as the incident beam, is accompanied by a modified scattered radiation of degraded frequency.

The new type of light scattering discovered by us naturally requires very powerful illumination for its observation. In our experiments, a beam of sunlight was converged successively by a telescope objective of 18 cm aperture and 230 cm focal length, and by a second lens of 5 cm. focal length. At the focus of the second lens was placed the scattering material, which is either a liquid (carefully purified by repeated distillation in vacuo) or its dust-free vapour. To detect the presence of a modified scattered radiation, the method of complementary light-filters was used. A blue-violet filter, when coupled with a yellow-green filter and placed in the incident light, completely extinguished the track of the light through the liquid or vapour. The reappearance of the track when the yellow filter is transferred to a place between it and the observer's eye is proof of the existence of a modified scattered radiation. Spectroscopic confirmation is also available.

Some sixty different common liquids have been examined in this way, and every one of them showed the effect in greater or less degree. That the effect is a true scattering and not a fluorescence is indicated firstly by its feebleness in comparison with the ordinary scattering, and secondly by its polarisation, which is in many cases quite strong and comparable with the polarisation of the ordinary scattering. The investigation is naturally much more difficult in the case of gases and vapours, owing to the excessive feebleness of the effect. Nevertheless, when the vapour is of sufficient density, for example, with either or amylene, the modified scattering is readily demonstrable.

C. V. RAMAN
K. S. KRISHNAN

210, Bowbazar Street,
Calcutta, India, Feb. 16

A Change of Wave-length in Light Scattering*

Further observations by Mr. Krishnan and myself on the new kind of light scattering discovered by us have been made and have led to some very surprising and interesting results.

In order to convince ourselves that the secondary radiation observed by us was a true scattering and not a fluorescence, we proceeded to examine the effect in greater detail. The principal difficulty in observing the effect with gases and vapours was its excessive feebleness. In the case of substances of sufficient light-scattering power, this difficulty was overcome

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*First Published in *Nature*, 121, 501, 1928.

*First published in *Nature*, 121, 619, 1928.

by using an enclosed bulb and heating it up so as to secure an adequate density of vapour. Using a blue-violet filter in the track of the incident light, and a complementary green-yellow filter in front of the observer's eye, the modified scattered radiation was observed with a number of organic vapours and it was even possible to determine its state of polarisation. It was found that in certain cases, for example, pentane, it was strongly polarised, while in others, as for example naphthalene, it was only feebly so, the behaviour being parallel to that observed in the liquid state. Liquid carbon dioxide in a steel observation vessel was studied, and exhibited the modified scattering to a notable extent. When a cloud was formed within the vessel by expansion, the modified scattering brightened up at the same time as the ordinary or classical scattering. The conclusion is thus reached that the radiations of altered wavelength from neighbouring molecules are coherent with each other.

A greater surprise was provided by the spectroscopic observations. Using sunlight with a blue filter as the illuminant, the modified scattered radiation was readily detected by the appearance in the spectrum of the scattered light of radiations absent from the incident light. With a suitably chosen filter in the incident light, the classical and modified scatterings appeared as separate regions in the spectrum separated by a dark region. This encouraged us to use a mercury arc as the source of light, all radiations of longer wave-length that 4358 Å being cut out by a filter. The scattered radiations when examined with a spectroscope showed some sharp bright lines additional to those present in the incident light, their wave-length being longer than 4358 Å ; at least two such lines were prominent and appeared to be accompanied by some fainter lines, and in addition a continuous spectrum. The relation of frequencies between the new lines and those present in the incident light is being investigated by photographing and measuring the spectra. The preliminary visual observations appear to indicate that the position of the principal modified lines is the same for all substances, though their intensity and that of the continuous spectrum do vary with their chemical nature.

C V. RAMAN

210 Bowbazar Street,
Calcutta, Mar. 8.

The Optical Analogue of the Compton Effect*

The presence in the light scattered by fluids, of wave-lengths different from those present in the incidental light, is shown very clearly by the accompanying photographs (Fig. 1)**. In the illustration** (1) represents the spectrum of the light from a quartz mercury vapour lamp, from which all wave-lengths greater than that of the indigo line have been filtered out. This line (4358 Å) is marked D in the spectrogram and C is the group of lines 4047, 4078 and 4109 Å. Spectrogram (2) shows the spectrum of the scattered light, the fluid used being toluene in this case. It will be seen that besides the lines present in the incident spectrum, there are several other lines present in the scattered spectrum. These are marked a, b, c in the figure, and in addition there is seen visually another group of lines which is of still greater wave-length and lies in a region outside that photographed. When a suitable filter was put in the incident light to cut off the 4358 line, this latter group also disappeared, showing that it derived its origin from the 4358 line in

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*First published in *Nature*, **121**, 711, 1928.

**Not reproduced.

the incident radiation. Similarly, the group marked c in spectrogram (2) disappeared when the group of lines 4047, 4078 and 4109 was filtered out from the incident radiation by quinine solution, while the group due to 4358 Å continued to be seen. Thus the analogy with the Compton effect becomes clear, except that we are dealing with shifts of wave-length for larger than those met with in the X-ray region.

As a tentative explanation of the new special lines thus produced by light-scattering, it may be assumed that an incident quantum of radiation may be scattered by the molecules of a fluid either as a whole or in part, in the former case giving the original wave-length, and in the latter case an increased wave-length. This explanation is supported by the fact that the diminution in frequency is of the same order of magnitude as the frequency of the molecular infrared absorption line. Further, it is found that the shift of wave-length is not quite the same for different molecules, and this supports the explanation suggested.

Careful measurements of wave-length now being made should settle this point definitely at an early date.

C. V. RAMAN
K. S. KRISHNAN

210 Bowbazar Street,
Calcutta, Mar. 22.

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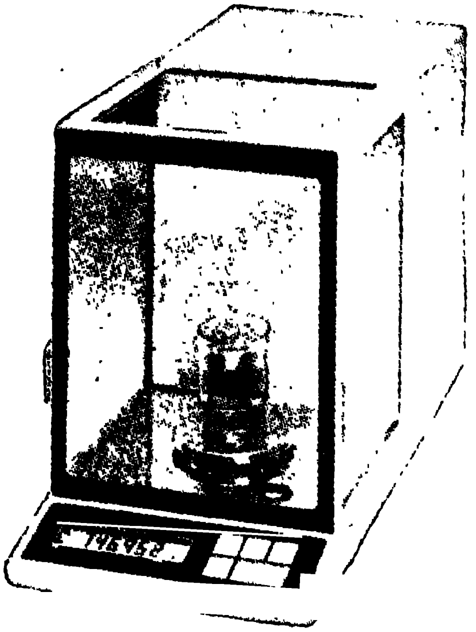

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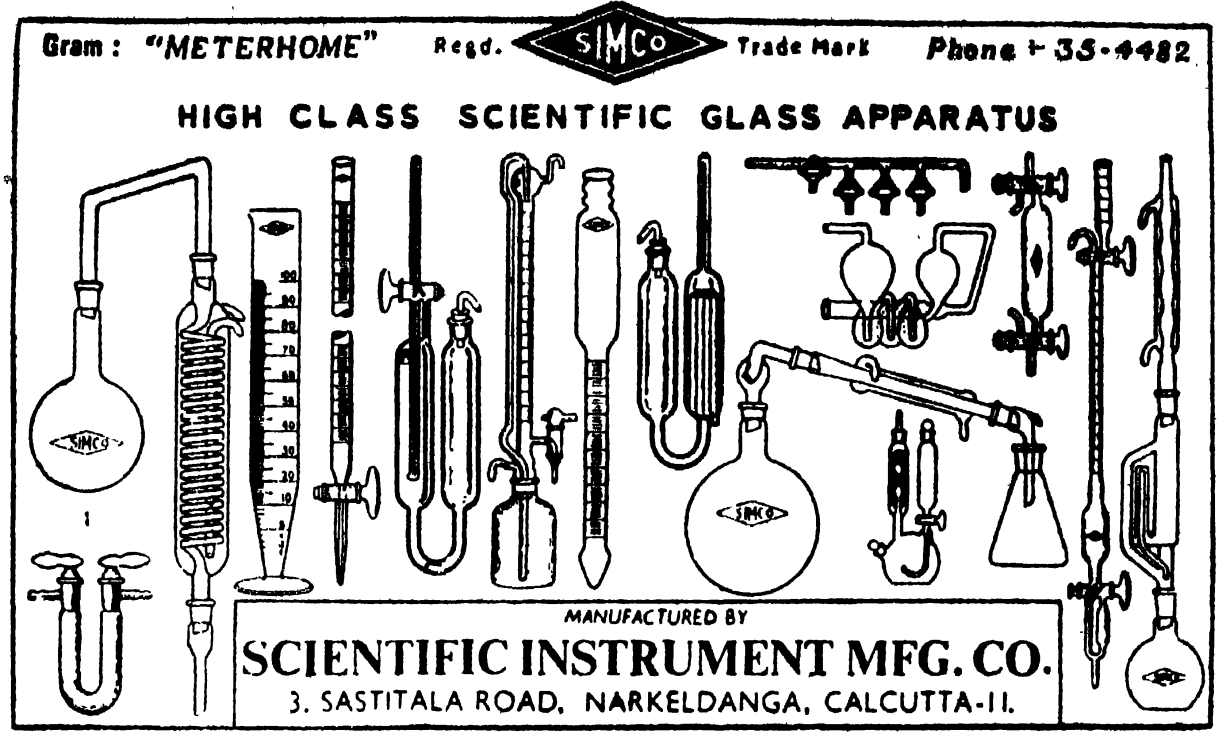

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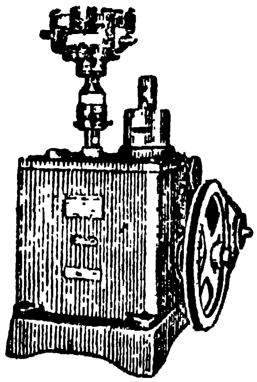

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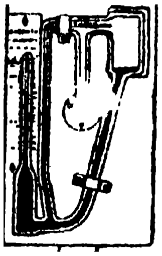

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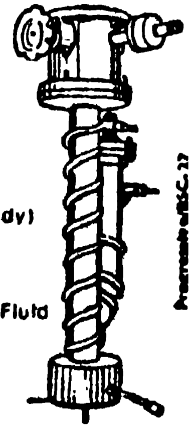

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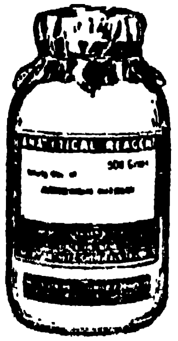

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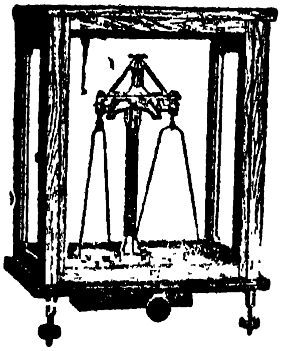

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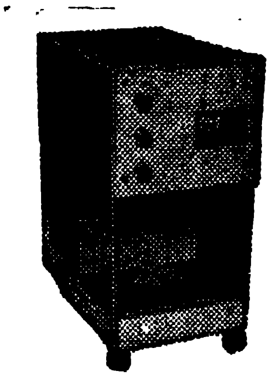

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SCIENCE
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CENTENARY GALORE

INDIANS love celebrations and a birth centenary of a national leader is an occasion enough to celebrate. The year 1988 happens to have a galore of birth centenaries of national leaders who made definite mark in shaping the destiny of India. Thus the year 1888 was a momentous one having given birth to so many illustrious children. September marked the birth centenary of Dr. S. Radhakrishnan, educationist, philosopher, statesman all put together (See September issue of *Science & Culture*). Now November resounds with the centenaries of Prof. C. V. Raman, the only Nobelist in Science till now, Pandit Jawaharlal Nehru, the first Prime Minister of India who really cast it development on modern times though firmly rooted in Gandhian philosophy ; Maulana Abul Kalam Azad, able companion of Jawaharlal but at the same time independent thinker.

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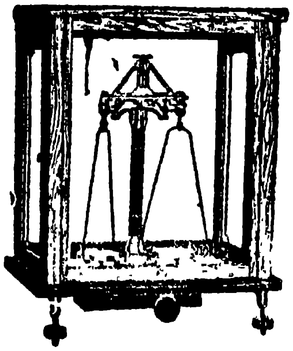

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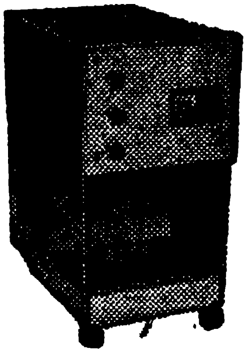

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1988. the birthday of Pandit Jawaharlal Nehru. He belonged not only to a state of his birth but the entire country as a whole. In fact, world was his arena of activity and tributes poured in from all quarters. He was the first Prime Minister of India and who shaped the future of India in the right perspective to fit into the progressive world. The shattered economy left by the colonial rulers had to be mended and a direction towards progressive improvement had to be given. As usually it happens, under such circumstances many are the advisers as there are active intellectuals and a person of action has to face strong criticisms. It was in-built in the nature of Nehru to carry with him, even his adversaries and strong critics, and make them see some logical reason for the actions taken. Those were the difficult days when he had to strive for upholding the ideals which he professed right after assuming the charge of his office. His disillusion after the Chinese attack was obvious which struck at the root of his idealism and his tired physical body could not give support to the weakened mind and he breathed his last after a short indisposition in 1964.

Pandit Jawaharlal Nehru was born with a silver spoon and had the best of education that was possible during his time. Though sheltered from the nationalist current during his boyhood days when he came in contact with it during his youth, it completely engulfed him. His father's sympathetic attitude towards national leaders and his involvement in the movement gave the cue to the young imaginative mind. Once fired with the nationalist spirit he never looked back. The iron was put into fire and on the anvil of British jails it was tempered to hard steel. The repeated prison life gave him the opportunity to think deeply over the world affairs and dream about India after glossing over its past.

During his prison days from October 1930 to August 1933 in the Naini Central prison, he was worried about his ailing wife and growing daughter whose education was suffering because of the lack of father's guidance. He thought of a novel method to make up the latter deficiency by writing to Indira regular letters with lessons on history which have become famous as Glimpses of World History. Since physical inactivity leads to introspection and varying moods, these letters reflect them in different forms and give personal touch which is unique to Jawaharlal Nehru. In the introduction to the first edition he cautions the historians : "I am afraid that the changing moods are very apparent in these letters and the method of treatment is not objective of a historian." Yet children, even today, enjoy reading this most readable book and gather knowledge.

Similarly when he was imprisoned in the Ahmedabad fort during the wartime (following Quit India movement) along with many leaders, Nehru's introspection further matured. With his colleagues from all regions of India, speaking different languages and following different religious faiths, Nehru did discover a unified, integrated India. During the four months—April to September 1944, he wrote the well circulated book 'Discovery of India'. Amongst his many colleagues in the same jail was Maulana Abul Kalam Azad, a learned person in classical languages and of high erudition. Though many of his Colleagues read the manuscript of the Discovery of India, Nehru specially mentioned in the preface about Maulana : "I should like to mention especially Maulana Abul Kalam Azad whose vast erudition invariably delighted me and sometimes also rather overwhelmed me."

Maulana was older to Nehru by just three days, as we celebrated his centenary on November 11th, 1988. His autobiography printed quite sometimes back has a few pages missing which according to his will were to be opened up and made public last year. There were scathing remarks about some of his colleagues during the negotiations for independence and partition of the country. As these statements are seeing the light of the day after so many years when the persons concerned are not alive to verify the authenticity, it stays as a opinion of a single individual about the events of the day and the historians will hesitate to draw any conclusion. But for this rancour created in the centenary year, people regard Maulana in high esteem for his sacrifice and intense love for the country. His contribution to post independent India will be remembered for a long time.

Nehru's term as a prime minister and the achievements have been reviewed by many who were close to him and had first hand knowledge. To quote from the comprehensive biography of Nehru by Dr. S. Gopal : "As his prime ministership drew to an end, Nehru could claim that under the plans, national income has increased by 42 per cent, food production by 16 per cent and industrial production by 94 per cent. Despite an increase of 21 per cent in population, food consumption had risen from 1,800 to 2,100 calories per capita and use of cloth from a little over 9 yards per year per head to 11.5 yards. It is only since mid sixties there had been noticable declaration in the process of growth. Above all Nehru made certain objectives so much a part of the general consciousness of India that they can today be taken for granted even if they have not been as yet fully attained—unity, democracy, civil liberties, secularism, a scientific and international outlook, planning to realise the vision of socialism. He provided India with a rich and many sided social morality".

Many are the books that have come out regarding the life and achievements of these great sons of India. Some highlight their achievements and in doing so try to bring down the achievements of other persons of yester years. Some try to throw light on weaker points of these leaders which should have been honoured as private affairs. The books might have become sensational and attained commercial success but will not have long term value. Our scriptures and heritage teach us that we should take only the good points from others, because they are the ones which have to be emulated. After all these great men were also human beings and they had their weakness of the species. It is the good that lasts long and generally people like to respect positive values.

To conclude this write up on centenary galore I cannot resist myself to quote from V. K. R. V. Rao's book on 'The Nehru legacy' :

"Unwilling to hurt or wound, with no sense of self or personal aggrandisement he made of his life a trust for the nation and indeed for all who were poor or lowly or disinherited wherever they were found. He believed in science and glorified its achievements, but science and technology were only handmaidens. His mistress was the people and their services was his worship." ☐

B. B. Baliga

ASTROPHYSICS AND SMALL OBSERVATORIES

J. C. BHATTACHARYYA*

NOT many years ago important discoveries in astronomy or astrophysics used to originate from small observatories ; the monopoly of giant telescopes in cornering all the glories of new findings was not absolute. Today, the position is not so encouraging for the small observatories ; most of the new discoveries come from the giant telescopes or the roving eyes of the spacecrafts, seeing in extra-visible radiations. The roof-top amateurs of yesteryears are facing strong obstacles in their efforts. The situation is rather critical in our country, where the old school of amateurs are passing out of the scene, leaving a void in our national scientific endeavours. The culture of science, the pursuit of pure basic knowledge, had always grown on efforts of generations of scientists ; such gap in the nature's endeavour is a matter of deep concern.

Two main reasons for this discouraging trend are (i) gradual deterioration of the environmental conditions and (ii) increased competitions from professional groups. A third reason, which is not an independent one, but a natural corollary of the main two, is the growing disinterest about such efforts among the young generation.

Environmental conditions are indeed bad. In urban centres of population, one does not see the starstudded vault of the night sky ; only the yellow canopy of the scattered city light is seen above. Except for the bright objects like the moon, bright planets and a few stars, existence of all other sources remains beyond our reception limits. It is difficult to expect a community of astronomers under such circumstances.

But yet, the position is not so hopeless. Away from the large cities, there are plenty of places where views of the starstudded sky may be seen as before. Air pollution, perhaps, has increased over the decades, but so has the advance of technology. Amateur astronomer of today can use photo-detectors in affordable prices, which are millions of times more sensitive than what his predecessors could dream of possessing. On the whole, small observatories of today can be much better equipped than one could hope a couple of decades ago. Objects which used to be faint for small telescopes, are now well within their reach.

Competitions from professional astronomers, with more powerful instruments are real, as a result of which, the painstaking efforts of small observatory scientists, in solving aspects of fashionable fields like the quasar or pulsar research may be fruitless. But there are several fields in astronomy and astrophysics, which are neglected by big observatories : not because, they are uninterested. These programmes demand much longer hours of observations, which cannot be accommodated in the observation routines. Small observatories with much less crowded programs, have a definite advantage in this aspect.

I am going to discuss several such programs, which may be profitably followed by small observatories. In matters of discoveries, they stand better chances of success, because the important element in such events is the alertness of the observers, which is expected in plentiness of committed observers in small places. Now-a-days, about dozen new comets are discovered every year : half of them are by amateur observers using small telescopes. Even the only bright Supernova in four hundred years, was discovered through a ten inch telescope, not through the array of large telescopes operating nearby !

There are several programs which may be adopted by scientists in observatories with modest equipment. A telescope size of 8 to 10 inches (20 to 25 cms) aperture will be adequate for most of the programs ; with 14 to 16 inches size telescope operations will be a lot more easy. Essential focal plane instruments may consist of a focal plane film/plate holder, for photography, and a solid state detector photometer for photometry.

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Most useful photographic program will be survey of selected regions and list variable and high velocity objects. One may look for variable stars, high proper motion objects, like asteroids. The process will be slow, it will take a few years before any discovery can result. And, of course, there are always chances of stumbling upon a new nova, or perhaps another, yet brighter Supernova.

The photoelectric programs will be more exciting. One may choose transient events like occultations, or regular systematic studies of variability of brightness. In the first case, one may adopt a regular program of lunar occultation observations and record light curves, from which diameters or duplicities of some stars could be determined. There are certain points of advantage for the small observatories in this experiment ; only bright, large diameter stars are measured by this technique, and small aperture telescopes give cleaner records. In fact, one cannot use large telescopes for this experiment without reducing the aperture by stops. The information thus obtained are extremely valuable, as no other direct method (except some under development) exists which can do these measurements, and diameters of many stars still remain to be accurately determined.

Lunar occultation observations are important in geodesy and selenography as well, and its data are eagerly sought. The predictions can be done by calculations with a hand-calculator and are remarkably accurate. I feel that these experiments are of the type which can create interest and excite enthusiasm in young minds.

Planetary occultations are rarer, and the photometric data more valuable. Many a time, clouds intervene such observations, and these rare chances are lost. A large enough network of small observatories, is the obvious answer to these difficulties. Big astronomical institutions in developed countries have mobile observatories to cover these events. In the U.S., NASA has a complete aircraft, the Kupier Airborne Observatory fitted with telescope and other focal plane instruments for these observations.

Another pioneering type of observations is possible by a network of small observatories. Minor bodies of the solar system often occult distant stars ; the occultation light curve can provide answers to many questions about these bodies. Their shapes and sizes, for example, are only speculated from indirect observations ; a closely knit network of occultation observers can provide direct measurements. A few successes in these types of events have been achieved recently by mobile observing teams but many more events pass away unobserved every year over the earth's surface.

Some of our present day scientists are not interested in making discoveries of commonplace celestial objects. They may be looking for some unknown physical processes involving very high energy particles or the quark-gluon plasma. Strange it may appear so ; but even the small telescopes of today are capable of producing experimental results involving such reactions. Several classes of variable stars, display unusual emissions and their variation characteristics. Cataclysmic variables include peculiar phases of evolution of binary stars, where extremes of physical conditions are attained resulting in emission of electromagnetic radiation over extended bands. Highlights of the drama are hidden in bursts of X-rays, but the physical processes leading to such bursts are betrayed by irregular or quasi-periodic light variations. These stars are generally faint, but the new developments in technology in the form of micro-channel plate image intensifiers can bring these within the reach of small telescopes. The complex way of light variations can be faithfully recorded, checked against various models and modifications introduced to explain enigmatic bursts. The idea of mass flows, accretion discs and hot spots has

Come in order to explain peculiar shapes of light curves, and those opened up new thoughts in high energy physics.

Astronomical observations, over the ages have opened up man's ideas and visions of nature and the universe. In recent past several such instances of astrophysical information opening up new chapters of physics have occurred. The subject of magnetohydrodynamics has grown around solar coronal and distant radio source structures ; the ideas of level—pumping, population inversion and generation of maser sources came to explain unusual strengths of some interstellar lines. The physicists have to delve deep into the mysteries of nuclear matter in order to explain certain observed peculiar characteristics of fast pulsar light curves. Observational proof of the existence of weird features like black holes is being sought, and it is only a matter of time before that is achieved.

In our efforts to understand basic laws of nature, astrophysical observations have several short commings, compared to laboratory experiments, but they have many advantages too. The main point is that while laboratory experiments have to be severely restricted within parameters capable of creation by technologies developed, astrophysicists can choose their samples from an infinite variety of objects, operating under unimaginable extreme physical conditions. A few million degrees hot plasma is a tall order to be fulfilled in the laboratory, but one can choose thousands of objects in the sky which are hotter and get important observations. Some of the very high energy cosmic ray particles reach levels upto 10^{19} eV ; the biggest accelerators on earth can somehow reach a millionth of this value. It has been estimated that a linear accelerator aiming to produce such particles should stretch from the earth to the sun—an obviously impossible task, with our present day technology.

Large telescopes extend our reach, provide with more samples for study of particular problems, but are not essential where the question of using new ideas to understand specific manifestation of nature is involved. What is important is a thorough familiarity with the various known objects in the universe, so that whenever any particular question in fundamental science arises, we must know where to look for possible indications. If the celestial samples are faint, faraway and rare, large telescopes capable of spotting them do exist in our country, and the authorities will be too glad to accommodate such bold observational programmes, seeking to unveil any part of our enigmatic universe. But the exercise must begin with small instruments, and familiarity with the skies must start. It is essential that free minds, unfettered by any of our earlier prejudices, should be able to consider new questions, suggest alternative ideas, and have access to the entire universe for verifying their convictions. □

PALYNOLOGICAL RESEARCH IN EASTERN INDIA WITH REFERENCE TO RESPIRATORY ALLERGY AND PAST CLIMATE

KASHINATH BHATTACHARYA* and SUNIRMAL CHANDA**

THE science of palynology deals with the study of various aspects of pollen-grains and spores. Pollen grains, the haploid microscopic male reproductive units of flowering plants, are generally produced in large quantities. The variations in pollen wall (exine) structures and sculptures together with the variations in number, position and character of germinal apertures in the wall, and shape provide the morphological diversities of the grains at the specific, generic or family level. After maturity, pollen grains are liberated and carried by wind, insects or other animal vectors or by both, of which only one is utilized for fertilization. The rest are dispersed in various ways and are suspended in the air for sometime. This phenomenon enables palynologists to study their role in human health ; thus, a new branch of palynology i.e. Aerobiology came into being. It is now a well-established fact that some pollen-grains and spores are responsible for human respiratory allergy or seasonal rhinitis.

The exine of pollen-grains and spores are highly resistant to decay due to the presence of a highly complex chemical substance popularly styled 'Sporopollenin', an oxidised copolymer of carotenoids and carotenoid esters. This acts as a key point to the palynologists because the fossilised but well-preserved pollen-grains help in the reconstruction of the past vegetational history and also for the interpretation of the depositional environment in terms of the present-day known ecological status of the plants. Based on the depositional pattern of the fossil pollen-grains and spores, the palaeo-environment, palaeophytogeography, plant evolution, biostratigraphy, dating of ages, etc., of a particular place can be established. A new branch of palynology i.e. palaeopalynology has been developed dealing with the fossil pollen-grains and spores of both Quaternary and pre-Quaternary deposits.

Aerobiology

The pre-requisite for atmospheric pollen studies is a sound knowledge of the ground flora and a well-stocked pollen herbarium. The atmospheric pollen-grains are generally trapped either by using the gravity-slide method or by volumetric-air samplers. The identification of the dispersed pollen is mainly done on the basis of comparison with the recent reference slides of pollen-grains made of the regional flora. It has been established that the anemophilous pollen-grains are lighter and are produced in larger quantities where the exine surface is generally smooth, whereas the pollen produced by the entomophilous plants are relatively larger, heavier with various types of exine ornamentations and are produced in a lesser quantity.

Respiratory or naso-bronchial allergy caused by pollen-grains is a very common disease. The tropical, temperate and coastal flora of India is so rich and diverse that it poses problems for the identification of air-borne pollen grains. Since the publication of Cunningham's[1] monumental work on the occurrence of air-borne organic matters in the atmosphere of Calcutta, it is after a long pause that enthusiastic workers in different parts of India revived interest in aerobiological research. Systematic aerobiological investigations in relation to respiratory allergy in Eastern India were initiated and successfully performed by Chanda and his co-workers[2-9] in the Bose Institute, Calcutta.

The atmospheric pollen-survey of some selected biozones of West Bengal and neighbouring states has been done in details. The biozones were selected on the basis of topographical, ecological and climatic conditions. The tropical

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zones include Calcutta, Kalyani, Durgapur, Jhalda, Jalpaiguri and Cooch Behar which covered from the foothills of Eastern Himalayas, Darjeeling, Kurseong and Gangtok from higher altitudes of the stations of Eastern Himalayas and Agartala from Tripura.

The accumulated data revealed that allergenically highly potent grass pollen-grains dominate in almost all biozones (Fig. 1). The other allergenic pollen-grains originate from *Acacia auriculiformis*, *Amaranthus spinosus*, *Azadirachta indica*, *Cocos nucifera*, *Carica papaya*, *Cassia fistula*, *Casuarina equisetifolia*, *Chenopodium album*, *Lantana camara*, *Mangifera indica*, *Trema orientalis*, *Xanthium strumarium*, etc. Darjeeling and Kurseong atmosphere was infested by two highly allergenic pollen namely *Alnus nepalensis* and *Betula alnoides* (Fig. 1). In addition to some coniferous pollen-grains. curiously such temperate pollen-grains also recorded from the air of Cooch Behar and Jalpaiguri at the foothills, may be due to long-distance transport from the Eastern Himalayas.

The magnitude of the problem related to atmospheric biopollution and allergy in India is alarming. Respiratory allergy or asthma. so far considered to be incurable if caused by pollen-grains. can now be tackled. To effect prevention, the following measures may be adopted :

(1) Eradication of generally offending plants and selecting trees for planting properly suited to the climate, but at the same time avoiding those which produce allergic pollen grains.

(2) Removal of patients from the place of habit to other places where such offending plants do not grow.

(3) Clinical application : Antigenicity of different air-borne pollen besides other inhalent allergens are tested by a standard clinical method. namely skin test on susceptible individuals. Desensitization, with vaccine prepared with allergenically significant pollen-grains, produce appreciable improvement in susceptible patients.

Palaeopalynology

The application of palynology in the studies of Quaternary and pre-Quaternary vegetational history and biostratigraphy however, has the potentiality of understanding the past vegetation and climate. Precise datings of the strata, in conjunction with vegetational history, may be obtained by employing radiocarbon methods for Quaternary deposits. Normally. the Quaternary microfossils occur in the sediment in a well-preserved condition having practically no difference between fossil and living pollen-grains due to their proximity to the immediate geologic past. The pre-Quaternary pollen types, where the relationship of fossil and living plants is uncertain. the fossil taxa are referred to form genera and form species. However, palynology may also throw light on the afforestation or deforestation phenomena in relation to pre-historic life-forms reflected by agricultural activities and forest clearances.

Since the first successful demonstration by Lennart von Post[10] of its application, this subject has been widely used by botanists and geologists all over the world. However, some Quaternary sediments have been pollen-analytically investigated in Eastern India, e.g. Bengal Basin and Upper Brahmaputra Basin [11-19]

The pollen-grains recovered from the subsurface peats of Calcutta and adjoining areas indicate a typical swampy mangrove vegetation in and around Calcutta about 7000 years before present resembling the present-day vegetation of the Sunderbans (Fig. 2). Continued river silting. occasional mild tectonic movements and increase in population have induced a southward migration of the forest.

The Quaternary vegetation of Brahmaputra Basin in Upper Assam was quite distinct and different from the prevailing tropical climate (Fig. 2) about 12,210 to 17,930 Y.B.P. The places of higher altitude of Eastern Himalayas in Assam territory were not affected by direct glaciation. Nevertheless. the plants bear the characters of temperate/sub-tropical climate. This is probably due to the influence of West Himalayan glaciation and its refrigeration impact on other neighbouring high-altitude areas. The *Carya*-

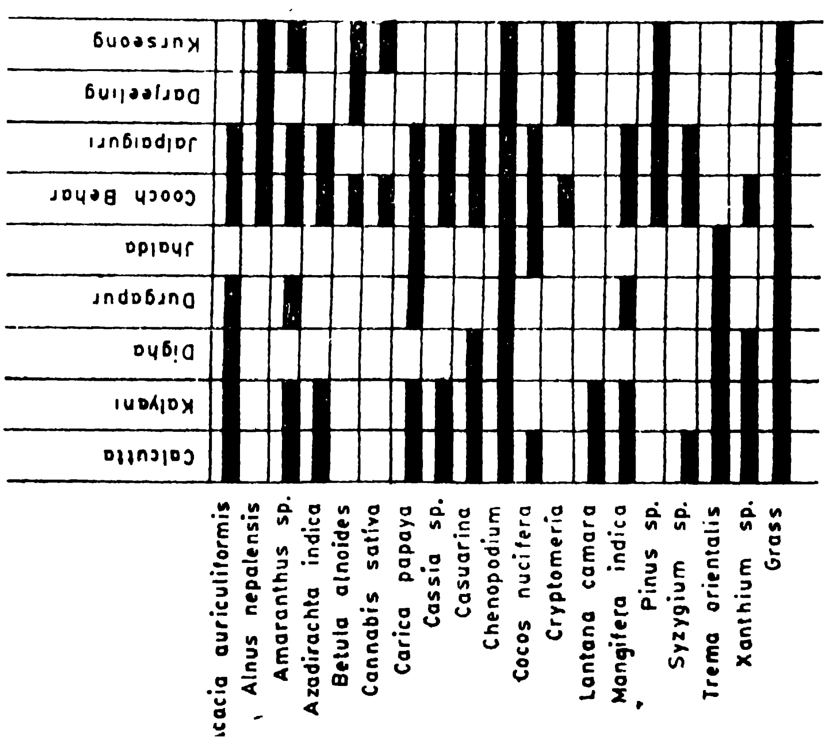

Fig. 1. Incidence of allergenic pollen in the different biozones of West Bengal.

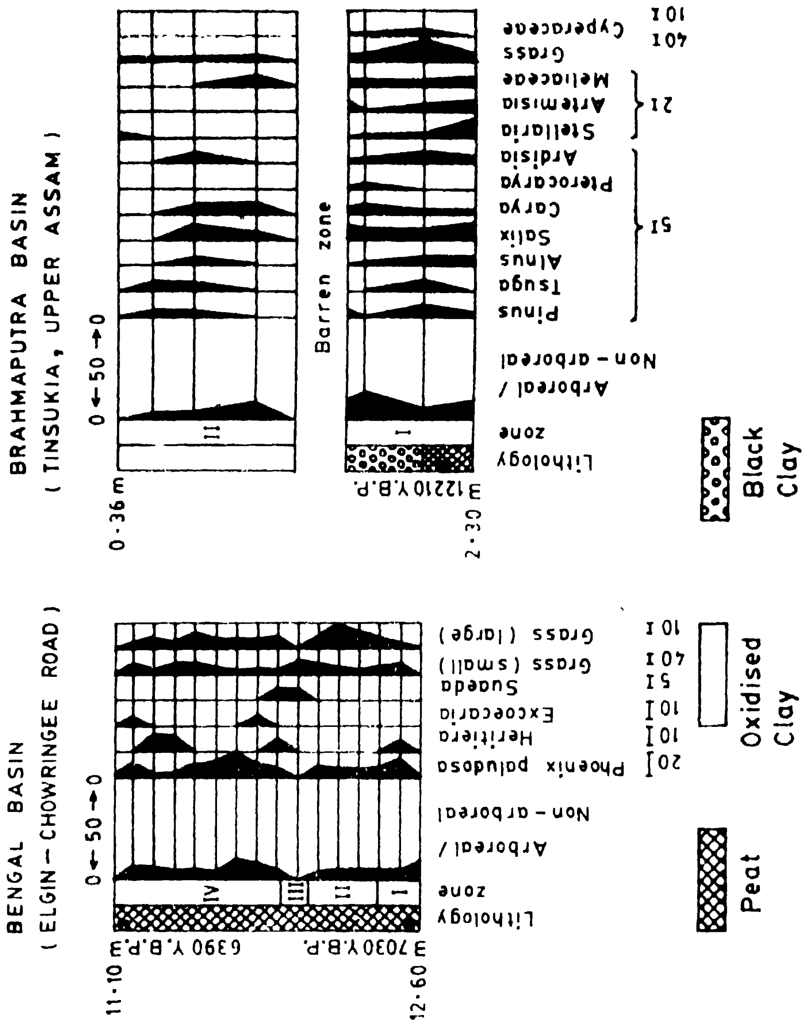

Fig. 2. Pollen diagram of Quaternary Sediments.

Pterocarya-Tsuga association indicates a typical flora of North-East Asia especially that of Japan possibly, suggesting a trans-migratory route between India and Japan during the time of deposition.

In future, more emphasis should be given to such studies because fossil pollen-grains have much greater advantage over the megafossils by virtue of the fact that only a little quantity of the samples are sufficient to unravel the past vegetational and climatic history. ☐

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Notes and news

Need for an Institute of Lighting and Vision Research

After food, clothing and shelter light is the fourth necessity of life in the modern society of to-day. Since the days of cave man natural light has been used for both outdoor and indoor work. But working time had been limited to daytime only during those days. With the growth of civilisation man has learnt to develope and use artificial light sources like oil lamp, candle light and gas-light as a substitute for daylight during night-time. While oil lamps and candles have been used indoor gas light has been used primarily in street lighting and other outdoor areas. Since the invention of modern incandescent electric lamp by Edison and Swan simultaniously in 1879 there has been a revolutionary change in our social life. Our working hours are no longer limited to day-time only. Factories all over the world are operating to-day round the clock through 24 hours of the day with the advent of the age of electric lamps of different types. The Ediswan carbon filament lamp has been followed by the development of low pressure tubular fluorescent lamps, T/Halogen and other discharge lamps, e.g. high pressure mercury vapour, low pressure sodium, high pressure sodium, and metal halide lamps. Because of the availability of these highly efficient modern light sources our day-time activities outdoor are being carried out by night too. Thus we are to-day watching soccer matches by flood-light during the evening too. Even India to-day can be proud of having more than one stadium of international standard—prominent among them are Nehru Stadium in New Delhi and Yubabharati Stadium in Calcutta. This is the blessing of modern technology in the field of lighting.

In terms of efficiency near by 200 lm/watt has been achieved in the case of low pressure sodium lamp against 2 lm/watt for the Ediswan carbon filament lamp. Colour of light has also been improved with the newer metal halide lamps which give sunlight/daylight appearance. All these have been achieved only in the advanced countries, specially, the UK, the USA and Germany, of the world. In India, we are manufacturing all those lamps except metal halide. But they are all based on imported technology and machineries/equipment.

Lighting as such covers a fairly wide field. The wide range of activities may be outlined as follows :

I. Production of light sources,

II. Applications of light sources—indoor and outdoor,

(a) Production of luminaires ; (b) Lighting Design,

III. Measurement & Testing—Photometry and

IV. Light, Vision and Work.

In India, following the British model of scientific research CSIR laboratories carry out research in the various fields of science and technology. As in the Building Research Station, Garston, England, daylight research is being carried out in the Central Building Research Institute, Roorkee (UP). NPL has been conducting routine photometric measurement and testing. But Indian lamp manufacturers are not carrying out any R & D work in the field of lamps and artificial lighting as is done bv the leading lamp manufacturers in the advanced countries. Only Photometry Laboratories are being operated by NPL and some leading lighting companies in India. The present status of lamps and lighting has been achieved by the leading companies like G. E. and Westing House (USA), GEC, Thorn and AEI (UK) ; and Philips (Holland) mainly. This includes work on visual performance and lighting design to some extent. The major investigations in the field of application are being carried out by the Electrical Engineering and Architecture Department of the Universities and the Polytechnics in the UK, USA and elsewhere. The problems being tackled involve visual and task performance and lighting design National Codes for Interior and Exterior lighting have been prepared by the respective Illuminating Engineering Societies on the basis of the results of subjective studies. So far, similar Indian Codes of Practice have been prepared on the basis of their results or International Codes are being used in some cases, e.g. sports lighting. Since the oil crisis of the seventies more attention has been given to energy effective lighting. Besides the lighting companies some public institutions abroad are actively engaged in innovation daylighting and artificial lighting. AERE/BRS (UK) and Lawrence Berkeley Laboratory (USA) are leaders in this field.

Fundamental researches involving interactions of light, eye, task and brain for understanding the basic principles of light, vision and work are also being carried out by the Institutes of opthalmology and the Schools of Medicine in the UK and the USA. This is an exciting field where the participants are physiologists, opthalmologists, biochemists, neurobiologists, psychologists, and lighting technologists.

Considering the above picture in the absence of similar research facilities in India we need a 'Central Institute of Lighting and Vision Research' in the immediate future. Instead of embarking on a huge infrastructure the nucleus of such an Institute may be set up at Calcutta between the University College of Technology and Jadavpur University. Later on IIT's and other universities may collaborate. While the lamp development and measurement projects may be started in the Electrical Engineering Department of Jadavpur University Application Aspects' and fundamental studies, as mentioned above, may be studied in the University College of Technology complex. The latter is the most suitable place for creating an inter-disciplinary school of research involving the Departments of Applied Physics, Physiology, Biochemistry, Psychology and the Institute of Radiophysics and Electronics. ☐

S. K. Guha

PM allays fears over nuclear power plants

The Prime Minister, Mr. Rajiv Gandhi, said here today that the Government would not allow the operation of nuclear plants which emitted radiation equivalent to those emitted by thermal power stations. Nuclear energy was the cleanest power available and there was no doubt about it.

The Prime Minister's remarks came in the context of opposition from some fishermen villages to the location of the proposed Soviet assisted nuclear power station at Koodangulam in Tirunelveli district. Two plants of 1000 MW each are proposed to be set up here Mr. Gandhi's attention was also drawn to the courting of arrest by the Pejawar Mutt Swamiji against the proposed nuclear power plant at Kalga in Karnataka.

Mr. Gandhi said there was some radiation even in the thermal plants. The indigenous technology and Soviet technology to be acquired for the Koodangulam nuclear power project had a double encasement for stringent safety. There would be no repetition of a Chernobyl in India in the case of any malunctioning of the plant, he asserted. ☐

The Hindu

Himalayas may be twice as old

The highest mountain system on earth, the Himalayas, may be twice as old, deep sea drilling experiments in the Indian Ocean have revealed. Till now, these mountains were believed to be 10 million years old. Now it appears that they had begun to form about 10 million years earlier.

The deep sea investigations were carried out by West German geologists, in cooperation with 23 other scientists -from eight, other nations, in a special project organised by the German research association, Deutsche. Forschungsgemeinschaft (DFG). The work was conducted within the framework of the International Ocean Drilling Programme (IODP). Drilling undertaken in 1987 by the vessel 'Joides Resolution' in the region south of Sri Lanka served as the basis of the investigations.

The borings brought up sediments of the finest rock components products of weathering transported from the Himalayas by the Ganges and Brahmaputra down to the mouths of their deltas. These rock components reach deep into the ocean as turbidity currents and finally sink to the bottom. This continuous process, spanning millions of years, led to the accumulation of sediment deposits, spreading much further south from the Bay of Bengal. They lie on a hard basaltic crustal mass formed from volcanic eruptions that constitutes the so-called Central Indian Ridge. This ridge is part of the global 60,000 km long mid-oceanic ridge system, a testimony of the new formation of the earth's crust. The crust, where the present drilling work is being carried out, has spread northwards at the rate of a few centimetres a year from the Central Indian Ridge.

The scientists studied the overlying layers of sediments in terms of their components on board the vessel's research laboratories. The age of the rocks could be determined with the evidence gathered from shells and skeletal remains of dead marine micro-organisms.

The geological history of the region, as believed by most geologists, dates back 140 million years ago, when India was still part of a gigantic continent in the Southern Hemisphere called the Gondwanaland (the name stems from the tribe of Gonds who lived in pre-historic India). For reasons unknown till today, this landmass broke up into fragments forming the various continents. India moved northwards with wide arm of the ocean named Tethys.

Sixty million years ago the Indian mass collided with the Eurasian landmass (comprising Europe and Asia). The Indian Ocean receded from India, resulting in the disappearance of the Tethys. In the period that followed the pressure exerted by India against Eurasia increased and led to the upliftment of the earth's crust at the fissure between the two continental landmasses and this uplifted mass is what we now see as the Himalayas. The finding of the deep sea project now dates this upliftment to 20 million years ago.

Continuous process : The key to the orogenical history of the Himalayas lies in its products of erosion which reached the ocean over millions of years and part of which were deposited at a distance of over 3,000 km from the place of origin. This process of erosion, according to geologists, will continue for over hundreds of thousands of years until finally these grandiose mountains are reduced to the levels of the plains.

The ICDP, a geological cooperative project, at present scheduled till 1993, aims at geological investigations of ocean floors. Its list of participants includes the USA, the Federal Republic of Germany, France, England, Canada, Japan and a consortium of 12 European nations under the European Science Foundation. ☐

The Hindu.

PM calls for 'Indianising' science

"It is ironic that the Raman Effect has found a wider applications in the West than in the country where it was discovered," the Prime Minister, Mr. Rajiv Gandhi, said at Calcutta on November 2.

In our country we have failed to link the laboratories to the developments for the welfare of the people. The nexus between the laboratory and industry is so weak that research takes a very long time to reach industry. Hence industry takes the option of taking technology from abroad than depending on indigenous technology," Mr. Gandhi said.

He was inaugurating the Sir C. V. Raman Birth Centenary celebrations and the diamond jubilee of the discovery of the Raman Effect in 1928.

Mr. Gandhi quoted C. V. Raman as having said that though he had tried to build up good science in India he had been depressed to find that what had resulted was a legion of camp followers of the West. "There is this ever present danger of falling prey to alien standards," the Prime Minister cautioned. To prevent such a situation, Raman's approach of Indianising science was useful.

Admiring Raman's love of nature from which sprang his scientific genius, the Prime Minister said the great scientist regarded nature as his true guru. "When we despair at our inability to expand and direct the curiosity of the younger minds, it is the failure of our education system," he added.

There had been a quantitative expansion of the education system but with a clear deterioration in quality. "What is needed is a significant improvement in the teaching of science. Scientific progress combines independent thinking and the right kind of environment and this is what needs to be provided," he said.

The centenary celebrations of Sir C. V. Raman is being held under the auspices of the Indian Association for the Cultivation of Science (IACS). Calcutta, where a major part of the Nobel Laureate's research work was carried out. It is being co-sponsored by the

Indian Academy of Sciences, Bangalore, which Raman founded and the Indian National Science Academy (INSA).

Raman's birthday is November 7. But November 2 is the birthday of the philanthropist and visionary Dr. Mahendralal Sircar who founded the IACS in 1876. The inaugural function was, therefore, held today to combine the two occasions. The inaugural was originally scheduled for the morning but due to the beginning of the winter session of Parliament today, it was shifted to the evening to enable the Prime Minister to attend it.

The Prime Minister unveiled a bust of Raman sculpted by Chintamani Kar and this will be installed on the IACS campus.

The Prime Minister dedicated to the nation a monument to be built at the place where Raman did his epoch-making experiment—210, Bowbazar Street (now known as Bipin Behari Ganguly Street), Calcutta.

The Raman Centenary Medals were awarded to about 40 distinguished Indian scientists.

Earlier, Prof. C. N. R. Rao, Chairman of the National Committee, said that Raman was the greatest experimental scientist India had produced.

Prof. Obaid Siddiqui, President of the Indian Academy of Sciences, said that Raman was "scientists scientist."

Dr. A. S. Paintal, INSA President, referred to the highly independent manner in which Raman did his research and said that there was a need to cultivate this independence of our predecessors." ☐

The Hindu

New Technologies for Augmenting Edible Oil Supplies

The Technology Mission on Oilseeds of the Government of India strongly believes that, apart from implementing measures to increase the production of oilseeds in the country, there is scope for an increment in the availability of edible oils from the already known sources through the relevant innovative technologies, waiting to be exploited.

The second Micromission on Oilseeds mainly deals with the postharvest and processing technology under the leadership of the Council of Scientific & Industrial Research (CSIR), New Delhi. It aims at (a) developing modern integrated processing technology for: major oilseeds, minor and unconventional oil bearing materials for edible use, (b) more efficient recovery of oils from oil bearing materials—improvements in ghanis and expeller units, (c) upgradation of oils to edible grade and (d) upgradation of oil cakes and extractions. In the field of handling, storage and processing, the CSIR and its constituent laboratories, especially Central Food Technological Research Institute, Mysore, Regional Research Laboratories at Hyderabad, Jammu, Trivandrum, Central Mechanical Engineering Research Institute (CMERI), Durgapur, and Structural Engineering Research Centre (SERC), Ghaziabad, would provide modern technology to evolve standard designs for storage in extending shelf-life and new processing techniques to improve the efficiency of oil extraction and for better utilisation of oilseed meals to produce ivariety of highly nutritious and delicious value-added products.

About the postharvest technology, the authorities of the Technology Mission on Oilseeds remarked that the CFTRI has moved swiftly to develop more efficient sunflower and mustard processing technologies and innovative and better rice bran stabilisation techniques. Presently, the country is losing five-lakh tonnes of oil of the value of Rs. 1,200 crores, which could be almost eliminated by more efficient handling, storage and processing. The CFTRI, based on its research experience, has adopted an integrated approach, involving proper storing, cleaning, sorting, size-grading, dehulling and decuticline of most oilseeds so as to eliminate the unwanten materials and to produce higher yields of good quality oil and edible grade cake suitable for fooduses. The technologists have been convinced that the emerging new technologies will hold the key for augmenting edible oil supplies in the country.

The sunflower seed, the newly emerging oil treasure of India, is becoming popular in the country, although its share in the total oil supplies is estimated at 2—3 per cent presently. Its oil is of good quality and is fit for deep fat frying. Removal of husk from the seeds improves both the quality of oil and the cake. The presence of chlorogenic acid which imparts dark colour to the cake is an important technological problem with sunflower seed. The technology developed by the CSIR Labs. has successfully solved this problem. Oil obtained from the new technology is low in free fatty acids and wax, and has an attractive bright yellow colour with pleasant flavour. The oil is superior in quality to the traditionally processed material. It is possible to achieve a 3% increment in the yield of oil from sunflower seeds dehulled before oil extraction, apart from getting superior quality protein-rich cake which can be used for human consumption after suitable processing. Preprocessing equipment for sunflower dehulling, namely, grader, sheller and air-classifier have been specially designed and three large-scale trials were conducted. The knowhow for beneficiation of sunflower seed developed by CFTRI has already been released to more than six entrepreneurs.

Production of better quality mustard/rape oil and cake is yet an another successful venture of CFTRI under National Mission programme for increasing edible oil supplies. Ghani-milled mustard oil is generally preferred to expeller oil because of pungency and flavour in the former. Presence of glucosinolates, an anti-nutritional constituent in the seed, low-levels of isothiocyanates responsible for pungency in the expeller oil and 12% residual oil in the cake are the technological snags associated with the processing of mustard/rapeseeds. An integrated process for extraction of oil with desirable colour, flavour and pungency from mustard seeds has been demonstrated at CFTRI. This process yields edible quality cake free from glucosinolates and also bitterness. It is bland and contains good quality protein which is nutritionally comparable to milk protein.

Rice bran—a byproduct of rice milling industry—has 20% oil. It has the promise of considerably swelling edible oil pool of our country, with a potential of six lakh tonnes of oil. The technological stumbling blocks that are in the way of utilisation of oil for edible purposes are many : Firstly, the high free-fatty acid content of the oil. This can be minimised by controlling the lipase activity in bran immediately after milling. This process is called stabilisation. Secondly, rice bran oil with a high wax content needs to be removed to render the oil fit for culinary use.

The main problem associated with the availability of bran suitable for extraction of oil is related to the huller mills which process 40% of paddy produced in the country. The CFTRI researches have led to the development of double pass system and double huller processing for yielding good quality bran suitable for solvent extraction. Low cost modification of existing huller mills have been demonstrated.

A break-through research conducted at the CFTRI has paved the way for simplified acid stabilisation process of rice bran in addition to thermal stabilisation technique developed earlier to inactivate lipase, the fat-splitting enzyme, to prevent development of free-fatty acid which renders the oil unsuitable for edible purposes. Rice bran stabilisers of variable capacities have been developed with built-in safety, simplicity and cost effectiveness to match the efficiency of the CFTRI process. Rice bran stabilisation units have been installed at five rice mills in Mirayalguda/ Mehaboobnagar, an important rice-producing town near Hyderabad in A. P. and at four rice mills of Food Corporation of India in Tamil Nadu. The rice milling industry has shown its appreciation for the equipment and also conveyed its acceptance.

Rice bran, thus stabilised is not vulnerable to insect attack. Plant and machinery do not suffer corrosion, contrary to the popular belief as per data from trials carried out by the Institute scientists. Actually, the corrosion of equipment caused by inherent FFA in conventional oil extraction operation is comparatively higher. Inter-lab studies involving Central Electrochemical Research Institute (CECRI), Karaikudi, and National Metallurgical Laboratory (NML), Jamshedpur, are in progress.

Pelletisation trials of chemically stabilised bran has been found to pelletise as easily as raw bran, without any alteration in the commercially processing conditions.

A process for dewaxing of crude rice bran oil with surfactant treatment has been developed and scale-up data have been generated.

A test-kit containing reagents to conduct simple and quick tests to check the free fatty acid content level in rice bran and oil has been designed and fabricated at the CFTRI. The test-kit can be used with ease and efficacy by bran suppliers, oil traders and housewives. Tests can be conducted even by unskilled labourers with minimum guidance. The test-kit would be made available to the interested parties against payment.

The CFTRI technologies have been made possible to avail toxin-free groundnut oil which is widely sought and produced in the country. Mouldy and fungal contaminated kernels which are normally crushed along with good seeds, affect the quality of both the oil and the cake. CFTRI has developed simple methods for detoxification of commercial unrefined oil—using special filter pads in oilseed crushing units and exposing to sunlight at the home level. Chemical treatment of the cake using ammonia or hydrogen peroxide will decrease the aflatoxin content to within permissible limits. The Institute has also demonstrated preventive method for controlling *aspergillus flavus* organisms producing aflatoxin by fumigation technique and improved storage systems. The Institute has developed inexpensive and nutritious products based on edible quality groundnut meal.

Soyabean, an oilseed, gradually gaining importance in India, has 20 per cent oil and 40 per cent protein, nearly twice as much protein compared to pulses. Currently, the material is being used as a source of edible oil and as such, it is being solvent-extracted and the meal is exported as animal feed. The CFTRI's approach for utilising soyabean is as a pulse extender. An integrated method for producing soyabean dal free from beany odour and anti-nutritional factors has been developed by the CFTRI. Recipes for utilising full fat, medium fat and defatted soya flour of edible grade in several traditional Indian foods have been worked out.

Thus, the CFTRI has given a new touch to the oilseeds for their exploitation as not only the source of edible oils but also as source of high protein foods and many high value products creating new and wider markets for the byproducts of oil industries.

Demonstration of all these proven technologies are being conducted at the Expo and Workshop on technology of oilseeds organised at the CFTRI, Mysore, at the instance of technology Mission on Oilseeds being held on 27 and 28 October 1988. ☐

CFTRI News Services

Letters to the editor

Studies on organ weight of the sheath-tailed bat *Taphozous perforatus perforatus* Geoffroy

Sheath-tailed bat, *Taphozous perforatus* (Chiroptera : Emballonuridae) is a desert dwelling colonial bat. This species is the second biggest group of bats in the Indian desert[1]. Detailed studies on its ecto- and endoparasites, Zoogeography and ecology were carried out[2-5].

The relationship between organ and body weights of many animal species were studied[6-8]. But limited information are available on Indian rodents[9-11].

Ten adult male and female specimens of bat were collected from Mandore, an artificial tunnel below Zanana garden (109 m × 9 m) 10 km north of Jodhpur, India in the month of July 1986 by net.

The bats were brought to laboratory and kept over night. They were weighed on a single pan balance (corrected upto ± 0.1 gm), sexed and sacrified by chloroform. Heart, intestine, kidneys (left and right), liver, lungs and spleen were dissected out and weighed on an electric balance (accuracy upto ± .001 mg).

Data collected in this study were statistically analysed by 'Student's 't' test[12].

TABLE 1 : Mean body weight (gms) of *T. perforatus*

Animal sex	Mean body weight	S.D.
Male (10)	20.35	0.96
Female (10)	20.68	1.50

(Figures in paranthesis indicate the number of animals used.)

Heart, liver, intestine, spleen, right and left kidneys of females were heavier than those of males in absolute weights while lungs were heavier in males than females (Table 2). This may be due to differences in body weights of two sexes. No differences were found in relative weights of different organs between the two sexes. However, significant differences (P < .001) were recorded both in the absolute and relative weights of intestine and only in the relative weight of spleen (Table 2).

Absolute weights of lungs, liver and intestine were heavier in *Taphozous perforatus* than those

TABLE 2 : Absolute and relative organ weights of male and female *Tophozous perforatus*. Values are Mean ± Standard Error (S. E.).

Organ	Male (10)		Female (10)		't' value between male and female	
	Absolute Weight (gm)	Relative Weight (gm/100 gm body wt.)	Absolute Weight (gm)	Relative Weight (gm/100 gm body wt.)	Absolute Weight (gm)	Relative Weight
Heart	0.22 ± 0.00	1.10 ± 0.02	0.22 ± 0.00	1.10 ± 0.03	0.39*	0.07*
Liver	0.81 ± 0.01	4.03 ± 0.10	0.90 ± 0.04	4.43 ± 0.24	2.19*	1.53*
Lungs	0.60 ± 0.00	2.98 ± 0.05	0.52 ± 0.02	2.57 + 0.13	0.03*	2.89*
Intestine	0.83 ± 0.00	4.11 ± 0.09	0.97 ± 0.04	4.75 ± 0.03	3.12**	6.68**
Spleen	0.06 ± 0.00	0.31 ± 0.00	0.08 ± 0.01	0.41 ± 0.02	1.99*	3.33**
Right kidney	0.12 ± 0.00	0.63 ± 0 01	0.13 ± 0.00	0.63 ± 0.01	0.95*	0.25*
Left kidney	0.12 ± 0.00	0.60 ± 0.02	0.12 ± 0.00	0.61 ± 0.11	0.67*	0.02*

* Non-significant.

** Level of significance P .001.

of *Rhinopoma microphyllum kinneari* while heart and spleen were heavier in *R. m. kinneari* than the former.

The relative weights of heart, liver, lungs spleen and intestine were heavier in both the sexes of *T. perforatus* than that of *R. m. kinneari.*

Higher relative weights of heart and lungs in both the sexes of *T. perforatus* than *R. m. kinneari* suggest that *T. perforatus* flies faster than *R. m. kinneari.* Heavier heart and lungs may be related to increased circulation and respiration[13]. Moreover heavier heart in bats than that of terrestrial animals may be related to volant adaptation[14,15]. This by possessing heavier organs, *T. perforatus* may be physiologically more adapted for aerial mode of life than that of *R. m. kinneari.*

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New record of coccinellids (Coleoptera) on Walnut trees in India

Walnut, *Juglans regia* L. is one of the most important dry fruit tree grown in the foot hills of the Himalaya over an area of 5000 hectares[1]. It has been reported to be attacked by 30 insect species and the Coleopterans rank the most serious ones[2]. Recent report[1] shows that a leaf minor belonging to the family Curculionidae is active in the Jammu and Kashmir area and causing serious damage to the Walnut crop. Our survey of the different areas reveal the presence of a good number of predatory as well as mycophagous species of Coccinellidae (Coleoptera) associated with the Walnut trees. We have been able to collect as many as 12 such species from the Walnut tree growing areas. The rearing of these species in a number and subsequent release in the Walnut growing areas can check the pestilence menace very effectively. Unfortunately there is no record of coccinellids from the tree in question from India and the only record of *Adalia bipunctata* (L.) is available from the British Coccinellidae[3].

Below is a list of the predatory and mycophagous species collected from *Juglans regia* L.

(i) Tribe—Coccinellini

1. *Calvia trilochana* Kapur
2. *Calvia durgae* Kapur
3. *Calvia pinaki* Kapur
4. *Calvia pasupati* Kapur
5. *Calvia obversepunctata* (Mulsant)
6. *Calvia* sp.
7. *Alloneda dodecaspilota* (Hope)
8. *Harmonia sedecimnotata* (Fabricius)
9. *Harmonia dimidiata* (Fabricius)
10. *Harmonia eucharis* (Mulsant)

(ii) Tribe—Psyllorini

11. *Halyzia straminea* (Hope)
12. *Halyzia sanscrita* Mulsant.

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Changes in protein, nucleic acid and histone content in the shoot apex during panicle initiation and in the leaves during monocarpic senescence of rice plant

Senescence is considered as a genetically programmed phenomenon in the life cycle of a plant and there occurs a change in the genome during senescence. Considerable research efforts have been made in analysing the mechanism of monocarpic senescence[1,2], but the actual mechanism is not precisely understood. Mondal[3] concluded that the genes for flowering are possibly linked to the senescence—inducing genes in monocarpic plants like rice. The basis of his conclusion was that all monocarpic plants die after flowering (dioecious male plants) or fruiting and senescence can only be prevented for an indefinite period by subjecting the plant under unfavourable photo-periodic condition. Changes in RNA and histone protein in leaves during ageing and senescence have been reported by several investigators[4,5], but their results are controversial. So it will be interesting to follow the changes in the biomolecules (DNA, RNA, histone and protein) in the shoot apex of rice plant during panicle initiation as well as in the leaves during reproductive development.

Healthy and viable seeds of rice (*Oryza sativa* cv. Kalojira) were supplied by Crop Research Farm of Burdwan University. Seeds were surface-sterilized in 0.1% (w/v) mercuric chloride ($HgCl_2$) for 1 min followed by washing several times in distilled water and allowed to germinate in Petri-dishes containing moistened blotting paper at 37°C in an incubator. Germinated seeds were sown in the seed bed and 30-day-old seedlings were transplanted from the seed bed to the field with one seedling per hill at a spacing of 25 cm×30 cm. The stem apices were collected from different aged plants (104, 107, 110, 113 and 116 days old) up to the advent of panicle emergence. The flag and second leaves were also collected from the rice plant at the different reproductive phases i.e. anthesis phase (125 days), grain-filling phase (152-132 days), grain-development phase (132-139 days), grain-maturation phase (139-146 days) and senescent phase (146-153 days) for the estimation of different biomolecules memtioned earlier.

For protein estimation, 100 mg plant tissue were homogenised with methanol and centrifuged at 6000 rpm for 10 min and the supernatant was discarded. The residual pellets were made phenol-free by washing successively with 80% ethanol, cold 10% trichloroacetic acid (TCA), ethanol, ethanol : chloroform (3:1), ethanol : ether (3:1) and finally with ether. Protein was estimated by Folin-phenol reagent according to Lowry et al[6]. RNA and DNA were estimated according to Cherry[7] and Burton[8], respectively. The histone protein was extracted from the plant tissue with cold 0.3 (N) Hcl and estimated according to Gornall et al[9]. Each experiment was repeated thrice with three replicates per set and the mean values are presented here. Standard errors (SE) are plotted in the figures.

A significant increase in DNA, RNA and protein and decrease in histone protein content was observed in the shoot apex (Fig. 1) up to the age of 107 days of rice plant (9 days before panicle initiation). The level of above biomolecules reached the original level at the plant age of 116 days. It was clear that the level of protein (Fig. 2A), RNA (Fig. 2B) and ratio between RNA and histone (Fig. 2E) of flag and second leaf of rice plant gradually decreased du-

FIGURE-1

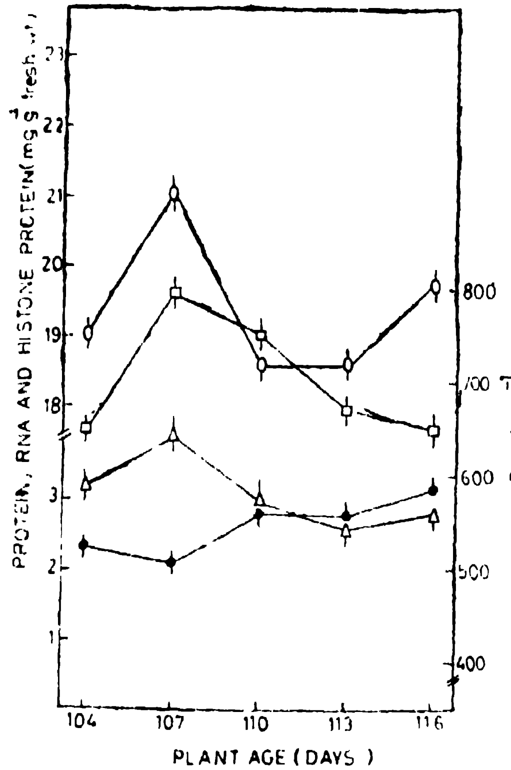

Fig. 1. Changes in the protein (0—0), RNA (△—△), DNA (□—□) and histone protein (●—●) content in the shoot apex of rice plant during panicle initiation.

FIGURE-2

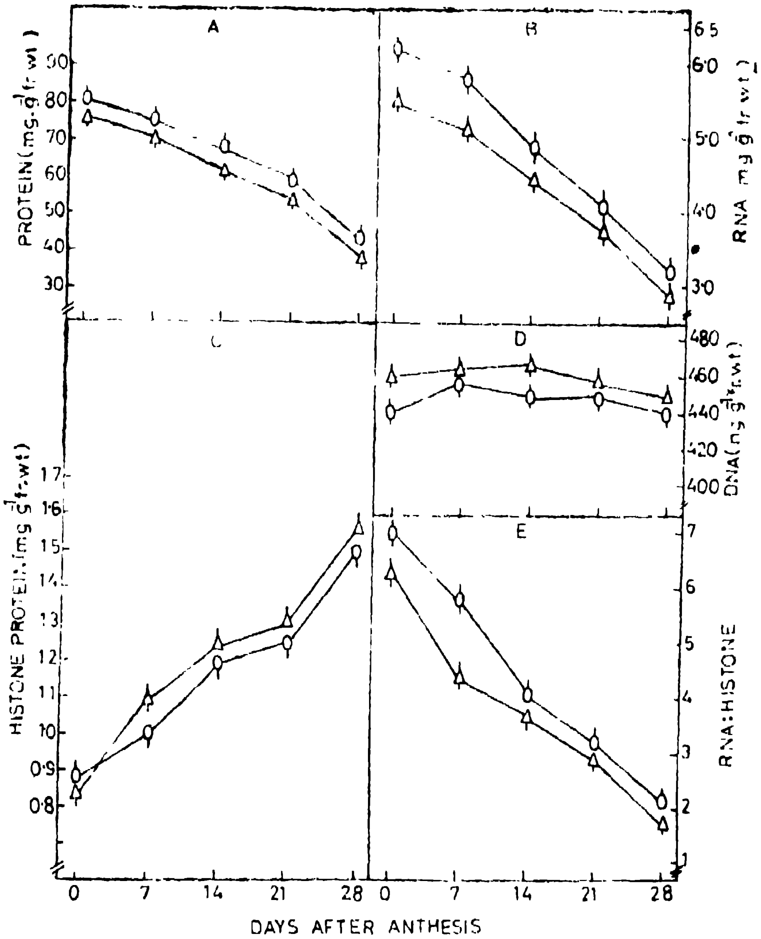

Fig. 2A—E. Changes in the protein (A), RNA (B), histone protein (C), DNA (D) and ratio between RNA and histone protein (E) in the flag (0—0) and second (△—△) leaf of rice plant during reproductive development.

ring the progress of reproductive development. But histone protein content (Fig. 2C) gradually increased. The change of DNA content (Fig. 2D) in the leaf samples of rice plant was less significant during reproductive development. The level of protein, RNA and ratio between RNA and histone remained highest in the flag leaf and lowest in the second leaf in all the stages of reproductive development. On the other hand, histone protein content showed an opposite trend, the highest being in the second leaf and the lowest in the flag leaf. The change in histone protein content had a distinct relationship with that of RNA content during ageing and senescence.

During modification of shoot apex from vegetative to reproductive state, the mitotic activity increased throughout the meristem for new cell formation. In the present study, both DNA and RNA content of the shoot apex of rice plant increased 9 days before panicle initiation. According to Seidlova[10], the activation of RNA synthesis is associated with floral differentiation. Just before panicle initiation (107 days old plant), the total protein content of shoot apex of rice increased. Cores et al[11] reported that the protein content increased during flowering and the type of protein synthesized is different from others. The present study shows that at the plant age of 107 days, the histone protein content of the shoot apex of rice decreased. Supporting evidence in favour of this can also be offered[12].

From the results of increase in DNA, RNA and total protein and decrease in histone content in the shoot apex of rice up to 9 days before panicle initiation, it may be assumed that the genes responsible for flowering are expressed and/or activated before panicle initiation.

The lower decline of protein and RNA content in the flag leaf indicated sequential mode of senescence of this rice cultivar. Thus, the consequence of the expression of senescence genes at the time of flowering is detectable with the ageing of leaves leading to senescence. But how this is mediated at the molecular level is far from clear.

The changes in DNA content of the two uppermost leaves of rice was insignificant during senescence. It was reported that DNA of the senescing tissue is more stable than RNA and decline only at the later stage of senescence[13]. In the present study with rice plant it was observed that during progress to senescence, RNA content of leaves gradually declined with concomitant increase in histone content. During ageing or senescence, the histone protein content of the tissue increased with the concomitant decrease in RNA[4]. From the increase in histone content and decrease in RNA content of leaves, it was obvious that the histone protein acts as an inhibitor of eukaryotic gene expression[14].

While a distinct correlation exsists between RNA and histone protein in the present study, it may be assumed that senescence is controlled by RNA metabolism which, in turn, is regulated through association and dissociation of histone protein with the DNA molecule.

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Study on nitrogen sparing effect on pea through edaphic rhizobial strain

Biofertilizers have been successfully employed as partial substitute to chemical N[1-3]. The symbiotic nitrogen fixers may meet complete N requirement in several legume crops. It has been emphasised to exploit the edaphic strains as they are acclamatised and suit well to the local environment. Keeping this in view, the locally adopted rhizobial strains from the root nodules of pea, were screened to field evaluate their effectiveness so as to incorporate in package of practices.

Seed of pea var. Rachna was bacterised with 6 day-old culture (10^8 cells/ml in YEMA medium). The treated seed was sown in well prepared mini plots of 1 m^2 on 26th of October 1985. The plots were supplied with recommended dose of P and K through SSP and MOP as basal dose. Since the preliminary study consisted of only comparing the nitrogen sparing *Rhizobium* effect against the untreated check, no chemical-N was applied. Observation in respect of length of seedling, dry weight of seedling, number of pods per seedling and total weight of pods per seedling was recorded at monthly interval starting from 1st of December 1985 till harvest in 2nd week of March 1986 and pooled average presented in the Table 1.

TABLE 1 : Yield and growth parameters as affected by *Rh. leguminosarum* in pea.

Treatment	Length of seedling (m)	Dry Wt. of seedling (g)	No. of nodules per seedling	No. of pods per seedling	Wt. of pods per seedling (g)
Rhizobium **inoculation**	1.13	8.572	10	12.50	23.17
Untreated check	1.03	5.691	6.83	8.83	17.33
% increase over control	9.70	50.623	46.41	41.56	33.70

The data (Table 1) indicate increase in growth dimensions and the yield over untreated check. Increase in dry weight by more than 50% and almost equally in nodule number speak of the good quality of edaphic *Rh. leguminosarum* RSP.

The same strain was used to assess the quantum of nitrogen fixation next year. The seed of pea var. Rachna was treated as before and sown in 12 m^2 plots in the 2nd week of November 1986. The delay in sowing was due to abnormal rains in the area. The distance between the rows and plants was 50 and 7.5 cm respectively. Phosphorus @ 40 kgs/ha was incorporated during preparatory tillage. The experiment was repeated thrice on a simple randomised block layout. The observational data were recorded thrice at monthly interval starting from 1st week of December. The pooled averages are presented in Table 2.

TABLE 2 : Yield and growth parameters in pea pulse crop as affected by *Rh leguminosarum* RSP.

Treatment	Length of seedling (m)	Dry weight of seedling (g)	No. of nodules per seedling	Grain yield (Q/ha)
Control	0.436	2.416	6	7.23
Rhizobium **inoculation**	0.483	3.750	12	11.84
3kg N/ha	0.473	3.200	6	7.93
6kg N/ha	0.540	3.900	5	8.43
9kg N/ha	0.610	4.333	7	9.61
12kg N/ha	0.673	4.783	6	10.93
15kg N/ha	0.660	4.650	7	12.04

The *Rhizobium* inoculated plants produced comparatively more pink nodules, which were bigger in size and in clusters, whereas in other treatments, the nodules were in variable sizes and scattered. The dry weight of seedling in *Rhizobium* inoculation was 50% more than the control. This was also true for treatments having 6, 9, 12 and 15 kg N/ha. The nodule number in *Rhizobium* treatment was almost double the number of nodules per seedling recorded in other treatments. The grain yield in inoculated plots was nearly equivalent to 15 kg of chemical-N. Hence it is recommended that chemical-N application be eliminated and seed treatment with *Rhizobium* inoculant be adopted for pea.

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Airspora of Santiniketan

The local people of Santiniketan and adjoining areas frequently complain of different types of allergic disorders such as respiratory diseases, bronchial troubles, asthma, sneezing etc. Keeping in view the fact that air-borne fungal spores along with pollen-grains play major roles in causing respiratory allergy, preliminary investigations on the prevalence of fungal spores were carried out in the University campus of Visva-Bharati, Santiniketan over a period of two years (July 1985—June 1987). Culture-plate exposure method was employed for trapping the air-borne fungal spores. Results obtained indicate that fungal spores are present in the atmosphere of the area throughout the year, but they appear in highest concentration during July to October. The most common spores are *Alternaria, Cladosporium, Curvularia, Fusarium, Aspergillus, Penicillium, Nigrospora* and *Paecilomyces*. Colonies of *Rhizopus, Cunninghamella* and *Choanephora* also appeared frequently. Besides, basidiospores were also trapped as evidenced by the development of colonies with mycelia showing clamp connections. It was noted that Basidiomycete colonies appeared only during and just after the rainy season, although the Deuteromycetes spores were obtained throughout the year. This coincides with the blooming of many macro-fungi, including species of Agaricales and Polyporales during rainy season in the area. A recent report[1] also reveals the existence of a rich airspora in Santiniketan containing spores mostly of Deuteromycetes and few Ascomycetes fungi. Trapping of basidiospores in the present investigation is an interesting information. Recently, it is thought that basidiospores may be implicated with asthma. Morrow and Jackson[2] noted an increase in acute asthma admission with increasing fungal spores in the air including spores of Basidiomycetes, *Botrytis* and *Cladosporium*. Incidentally, it may be noted that several years back, while surveying sputum of bronchial asthma patients for the presence of fungal spores in a Hospital in Calcutta, on several occasions, the present author recovered Basidiomycete cultures developing mycelia with clamp connections in agar media. In some instances, there also appeared poroid fruitbodies in culture producing typical basidiospores.

However, extensive survey of sputum of asthma patients as well as of airspora is necessary to establish the implications of Basidiomycetes fungi in asthma.

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De-greening of carambola fruits by steeping fruits with brine water

Steeping fruits in brine water before selling is a common practice amongst fruit traders in West Bengal and other parts of the country. The treatment is given for a number of reasons, e.g. to remove or reduce the intensity of astringency, sourness, pungency or bitterness of the fruits, de-green them for attracting consumers or even as a disinfectant wash to avoid possible rotting of the fruits when they need to be marketed for several days. Despite some good results obtained in some fruits, many fruits are threatened with physiological injury due to such practices, particularly as suitable concentrations of salt solution and durations of soaking in them are often not properly maintained by the traders. The present study makes an attempt to examine the qualitative behaviour if carambola (*Averrhoa carambola* L.) fruits by steeping them in salt solutions of a wide range of concentrations.

Mature carambola fruits borne by a single tree, growing in the South 24-Parganas district of West Bengal, were harvested and brought to the laboratory in a moistened cloth bag. From the harvested lot, those which were completed green and have not started ripening (as determined by lack of yellowishness on any part of them) were sorted out ; such fruits were 5.5—7.0 cm long and 3.2—4.0 cm wide (at the maximum bulges) and were only used for the study. Experiments were started within 10 hr of harvest from the tree during the later part of December, 1987. Before any treatment, the representative samples were analyzed for their pomological qualities, which consisted of determining their weight, specific gravity, texture, colour as well as the total soluble solids (TSS). total titratable acidity and the vitamin C content. The specific-gravity values of fruits were determined by considering the weight and volume of the fruits, the latter by water-displacement method while their texture was known by hand-feeling and surface colour by visual observations done by a panel of informations. The TSS levels of the squeezed out fruit juice were determined with a refractometer and the acidity as well as the vitamin C content of the samples made from the pulp were estimated volumetrically by titrating respectively against NaOH soln of known normality[1] and 2, 6-dichlorophenol indophenol dye soln[3].

Treatments consisted of dipping the fruit samples in freshly prepared aqueous solns of sodium chloride (lab. grade) of 1, 4, 8, 12, 16 and 20% conc. (w/v) in glass jars, including the control, identically dipping in distilled water, taking care that the fruits were completely immersed in the respective treatment solns or in the distilled water. After soaking for 3 hr, the fruits were brought out of the jars and maintained in ventilated atmosphere for 24 hr after which they were assayed for the same qualitative constituents as done earlies. Each treatment was replicated thrice, using four fruits in each replicate and the average data have been presented (Table 1).

Fruits steeped with brine water became more and more soft and de-greened with increasing concentrations of salt. No increase in weight and specific gravity of the fruits was clear due to various treatments. On the other hand, soaking

TABLE 1 : Qualitative behaviour of the fruits under various treatments.

Soaking in salt soln (% w/v)	Qualitative constituents of fruits							
	Wt fruit	Sp gr/ fruit	Texture (*)	De-greening (*) (*)	TSS (%)	Total Titr. acidity (%)	TSS : Acidity	Vit C (mg%)
Control (0%)	50.60	0.89	H	0	5.00	1.78	2.83	137
1% (w/v)	41.00	0.97	M	1	4.50	1.70	2.69	144
4% (")	42.60	1.00	M	2	4.50	1.64	2.74	89
8% (")	40.60	0.97	S	2	4.80	1.79	2.72	109
12% (")	46.50	1.03	S	3	5.40	1.76	3.10	116
16% (")	45.60	0.97	S	3	5.20	1.61	3.23	137
20% (")	46.50	0.95	S	3	5.06	1.67	3.44	136
24% (")	42.60	0.97	S	4	5.50	1.60	3.44	137
C. D. (5% level)	16.55	0.15	—	—	0.78	0.17	0.45	38
S. E. of diff.	5.59	0.05	—		0.26	0.05	0.15	13
Before treatment	24.76	0.95	H	0	4.26	1.72	2.40	25

(*) H = Hard ; M = Medium hard ; S = Soft ; (*) (*) = Extent of de-greening.

with higher doses tended to reduce fruit weight, possibly due to the phenomenon of exosmosis. Some decrease in the acidity and increase in the TSS levels could be seen in fruits which were steeped particularly with higher levels of brine water (Table 1). Although steeping of emblica fruits in brine water was observed by Mazumdar[2] to result in the loss of vitamin C of fruits, such loss of the vitamin could hardly be noted even when they were soaked in 24% salt soln. It needs mentioning here that soaking was done for 3 hr only in the present study, unlike 7 days of steeping allowed by Mazumdar[2] in emblica fruits.

The present findings are indicative of the fact that steeping carambolas in brine water have made them de-greened without rendering much loss in their constituents of qualitative value. Neverthless, it is noteworthy that the brine-water induced de-greened fruits assumed whitish rather than yellowish appearance, which usually do not have greater acceptance in the market and that such fruits also did not keep well. Steeping carambola fruits in brine water of more than 8% level could never be advocated if the soaking is continued upto 3 hr, because such treatments wilted the fruits starting from the ribs and gradually extending up to the core of the fruits. Furthermore, fruits treated at such higher dosage turned extremely soft within a day.

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Role of molybdenum on symbiotic nitrogen fixation in redgram [*Cajanus cajan* (L.) Millsp]

Importance of molybdenum was not felt until it was observed that traces of the element markedly stimulated growth and nitrogen fixation in Azotobacter[1]. Several workers have studied the effect of molybdenum application on symbiotic nitrogen fixation in legumes. The results of such studies have varied from no response[2] to significant increase[3] in nitrogen fixation due to molybdenum application. Such variations in field situation could be attributed to (1) variations in molybdenum content of soil and (2) differences in methodologies in application of molybdenum to seed. Studies were undertaken to find the effect of seed treatment of molybdenum on nitrogen fixation in redgram, an important pulse crop.

The studies on effect of molybdenum seed treatment on symbiotic nitrogen fixation in redgram were conducted under green house conditions. The plants were raised in 8 kg soil : sand mix in the ratio of 9:1 contained in a black polythene bag. Molybdenum was applied to the seeds in the form of sodium molybdate at the rate of 0, 0.5, 1.0, 1.5, and 2.0 g/kg seeds before sowing. A sticker solution of Arabica gum was used for coating the seeds with sodium

TABLE 1 : Effect of different levels of molybdenum on symbiotic nitrogen fixation in redgram :

Mo levels g/kg seeds	Average nodule size (mm)	Nodule no./pl.	Nodule dry wt. (mg/pl.)	Shoot dry wt. (g/pl.)	Root dry wt. (g/pl.)	Total plant dry wt. (g/pl.)
0.0	3	31	382	8.55	2.84	11.39
0.5	3	41	392	8.07	2.98	11.05
1.0	4	57	438	9.93	3.23	13.16
1.5	6	64	508	10.82	3.32	14.14
2.0	3	31	755	9.81	3.80	13.61
C. D. (5%)		30	98.93	0.98	0.53	1.23
SEM		14	42.33	0.47	0.25	0.59
CV (%)		43	13.00	7.90	11.70	7.20

molybdate. The seeds of red-gram variety Hy-3C were inoculated with *Rhizobium* UASB 722 obtained from the culture collection centre of the laboratory. Observations on nodule size, nodule number, nodule dry weight, shoot dry weight, root dry weight and total plant dry weight were recorded after 60 days.

Application of 1.5 g sodium molybdate per kg seeds resulted in maximum increase in nodule size, nodule number, shoot and total plant dry weight (Table 1). The nodule mass and root dry weight were maximum at 2.0 g/kg seeds of molybdenum. In general increase in molybdenum levels from 0 to 1.5 correspondingly increased nodulation and plant growth. Thus seed treatment with molybdenum enhanced symbiotic nitrogen fixation and a level of 1.5 g sodium molybdate per kg seed was found to be the optimum for maximum symbiotic benefits. Further increase from 1.5 to 2.0 g/kg seed significantly reduced the nodule size, nodule number and shoot dry weight, while the nodule mass increased significantly with no effect on shoot dry weight.

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Formation of adventitious roots in capsularis jute (*Corchorus capsularis* L.) as affected by new varieties grown under flooded conditions

The capsularis jute (*Corchorus capsularis* L.) forms adventitious roots from lower part of the stem when the stem is under water stagnation for a long period[1,2]. The adventitious roots excrete some growth-promoting substances[2,3], which are very helpful for the ramification of roots in wheat and *mung*[2,3], if seeds are soaked with excertion. In the multiple-cropping programme, preceeding jute helped in increasing the growth of wheat[5] and *mung*[6] ; this might be due to root-excretion of jute. As this root-excretion is very important for root ramification and crop yield, it is necessary to know the number and length of roots in jute. But information regarding root formation and excretion of root of jute is very meagre. Hence, this information was collected from new *capsularis* jute varieties grown under flooded condition.

The field experiment was conducted during *Kharif,* 1987, with seven new capsularis varieties (TCJ 18, No. 8007, TCJ 19, KCM 4, No. 8005, TKCJ 17 and No. 8002) at the Seed Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal (741 235) fitting in RBD. *Capsularis* varieties were sown on April 21, 1987 in lines 25-cm apart @ 6 kg of seed/ha, applying 60 kg N, 40 kg P_2O_5 and 40 kg K_2O/ha. No irrigation was given but weeding was done manually twice at 15 and 30 days after sowing Simultaneously, thinning was done keeping plants at a distance of about 10 cm in line. The experimental field was flooded with water coming from the river Bhagirathi (Ganga) on August 17, due to flood in the area ; water stagnation was there in the field up to the end of September. The water height in the field was about 0.6 m above the soil. During water stagnation with flooded water, the new adventitious roots were formed on the lower portion of the stem which was under water for a long period. Observations on number and length of main an secondary roots of adventitious roots of different varieties were recorded on September 28 from 5-cm^2 area of the stem, taken 5 cm above the soil level. The number of main root, length of main root, number of secondary roots per main root, length of secondary root, total number of secondary roots, total length of main root, total length of secondary root per 5 cm^2 and total root length per 5-cm^2 were statistically analysed and summarised in Table 1.

TABLE 1 : Formation of adventitious main and secondary roots of capsularis jute (*Corchorus capsularis* L.) as. affected by new varieties under flooded conditions

Capsularis jute variety	Number of main root/ 5 cm^2	Length of main root (cm)	No. of secondary root/ main root	Length of secondary root (cm)	Total no. of secondary root/ 5 cm^2	Total length of main root (cm)/ 5 cm^2	Total length of secondary root (cm)/ 5 cm^2	Total root length (cm)/ 5 cm^2	Stem colour
TCJ 18	27.00	11.25	5.50	0.85	151.00	306.00	127.70	434.20	Pink
No. 8007	7.75	9.25	10.25	1.03	81.00	72.75	82.25	155.00	Green
TCJ 19	15.75	12.25	22.75	1.45	356.75	192.00	517.23	709.23	Pink
KCM 4	33.75	16.00	29.75	1.78	991.00	538.75	1775.10	2313.85	Red
No. 8005	21.25	18.25	21.00	1.50	441.50	390.25	658.80	1049.05	Green
TKCJ 17	25.50	12.75	15.00	1.25	383.25	322.00	469.88	719.88	Pink
No. 8002	22.75	24.75	22.25	1.60	467.50	560.75	746.25	1303.25	Green
Mean	21.76	14.93	18.07	1.35	410.29	340.43	625.32	965.21	—
S. E	1.43	1.23	1.11	0.07	82.86	99.16	120.08	180.49	—
C. D. 5%	4.26	3.88	3.28	0.21	27.89	33.37	40.41	80.75	—

It was revealed that the number of adventitious main roots per unit area was statistically significant (Table 1). The variety KCM 4 showed the highest number of adventitious main root followed by TCJ 18 and TKCJ 17, while No. 8007 showed the lowest number of adventitious main root preceeded by TCJ 19 and No. 8005. Length of the adventitious main root was significant and variety No. 8002 showed the highest length followed by No. 8005 and KCM 4, whereas No. 8007 showed the smallest length of adventitious main root preceeded by TCJ 18 and TCJ 19. The number of adventitious secondary root of variety KCM 4 was the highest followed by TCJ 19 and No. 8002, whereas TCJ 18 showed the lowest number of adventitious secondary root preceeded by No. 8007 and TKCJ 17. Length of adventitious secondary root was highest in variety KCM 4 followed by No. 8002, whereas the smallest one was obtained from TCJ 18 preceeded by No. 8007. The total number of adventitious secondary root was maximum in variety KCM 4, whereas the minimum number was obtained from No. 8007. The total length of adventitious main root was the highest in KCM 4, whereas the lowest was obtained from No. 8007. The total length of adventitious secondary root was maximum for variety KCM 4, while No. 8007 showed the minimum length. The total root length per 5 cm^2 area was the heighest in KCM 4, whereas lowest figure was observed in No. 8007. It was also shown that the jute varieties TCJ 18, TCJ 19 and TCJ 17 were pink in colour, while No. 8007, No. 8005 and No. 8002 were green in colour but KCM 4 was red in colour.

Cosidering the number and length of adventitious main and secondary roots in different varieties of capsularis jute and stem pigmentation, it is concluded that red-pigmented variety KCM 4 was the best for survival with adventitious root formation under water stagnation condition, as it formed profuse roots in stem. Hence, KCM 4 may be recommended for low-lying areas where water stagnation is very likely to occur.

Further work is in progress.

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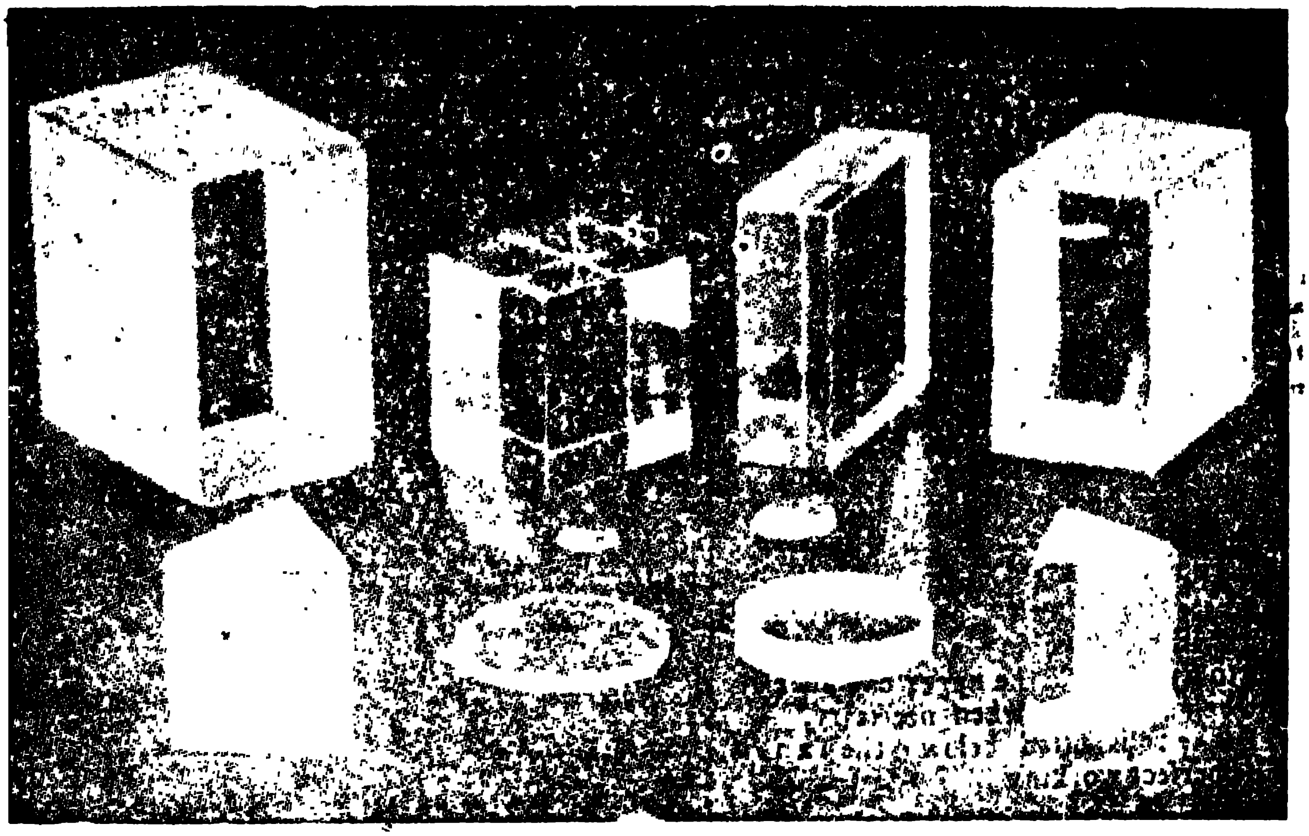

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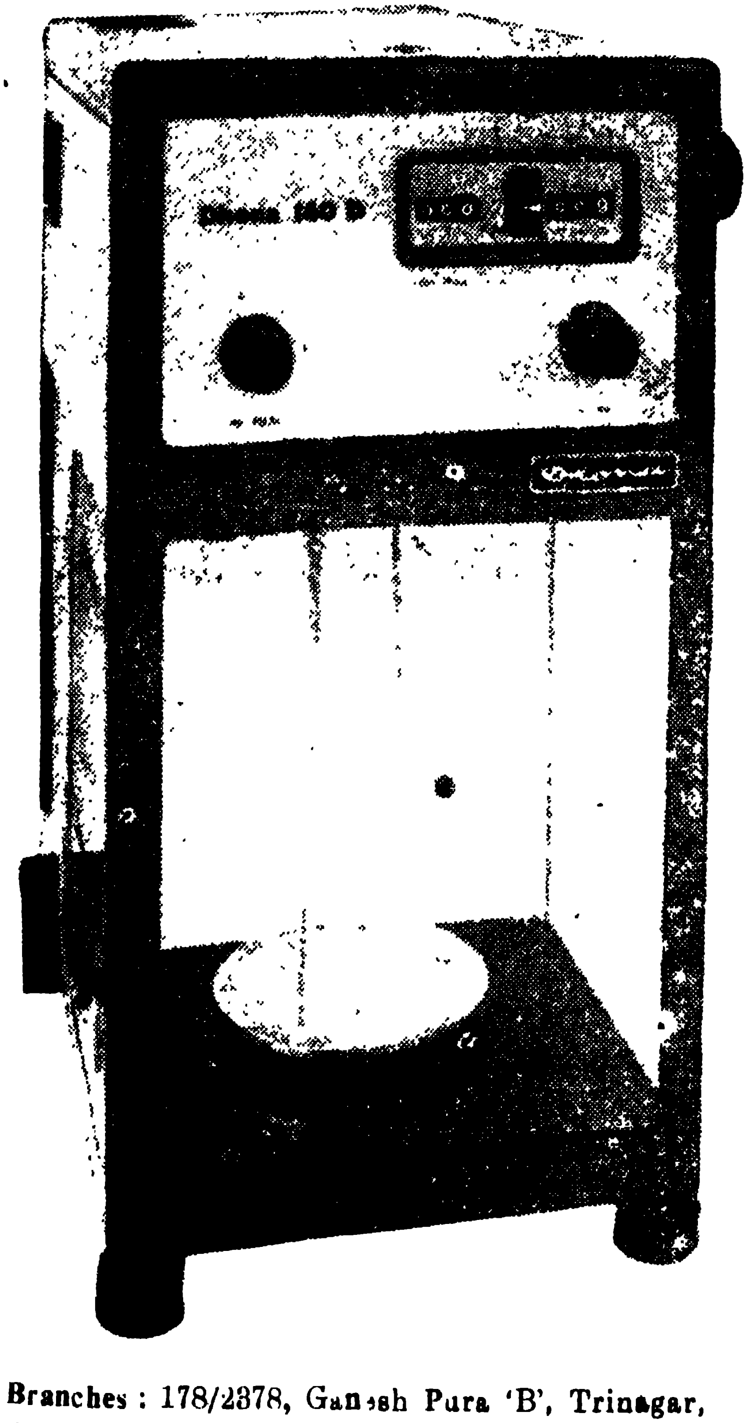

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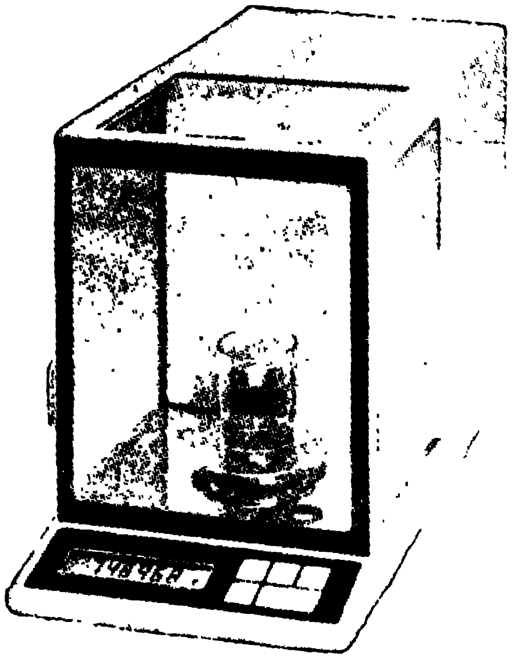

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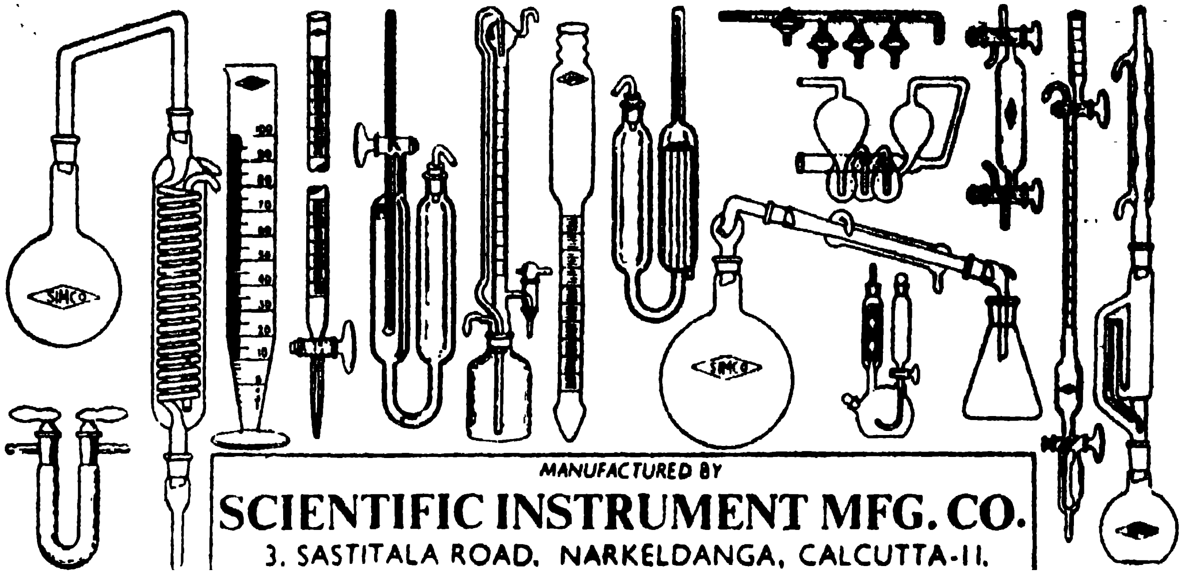

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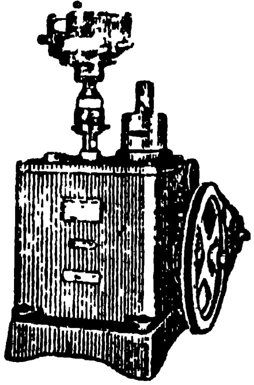

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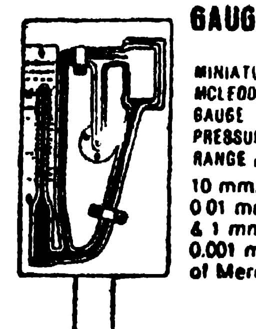

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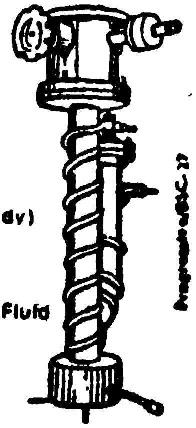

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PURSUITS IN SCIENCE—INDIAN SCENARIO

SCIENCE is systematic knowledge having its origin in man's endeavour to unravel the mysteries of nature and developing the skill to provide for the arts and comforts of life. Indeed science as specialized knowledge is of little relevance unless its application does any good to humanity. In fact, the value of any scientific research is best judged by the part it plays in the promotion of human welfare, and science has played a very vital role in the progress and prosperity of human race and advancement of our civilization. The Nobel Prize winner Professor Glenn T. Seaborg had once said quite appropriately, "Just as middle ages man could not ignore the church, nor Rennaissance man the arts, nor eighteenth century man political thought, so modern man cannot ignore science". However, it is also necessary to remember that science also should not ignore man. It is necessary to bear in mind that although science has played a pivotal role in the progress and prosperity of human race and advancement of our civilization, it has also been responsible in our time in bringing miseries to mankind because of indiscriminate and ill-designed applications. In this connection the application of some deadly poisonous chemicals such as the nerve gases in chemical warfare by some power crazy nations of the world and many such abuse of science come to our mind. Knowledge can be used either for good or evil, for which we can hardly blame knowledge or its cultivation and promotion. It is necessary to remember that what can be initial terror may eventually become a blessing and vice versa. Use of nuclear fission as a source of energy, nerve gases in cancer therapy, etc. are examples of one type. Nuclear fission brought about unprecedented devastation and destruction in Hirosima and Nagasaki in Japan in the year 1945 and the same process has the potentiality to provide an unlimited supply of energy in a world likely to face a severe energy crisis due to depletion of the fossil fuels. However, the use of insecticides like the DDT and several other chlorinated hydrocarbons, which are not easily bio-degradable, which were once considered as boon to mankind in the eradication of many insect borne deadly diseases, are now of serious concern owing to severe ecological damage caused by their widespread use. Similarly, the automobiles, aircrafts, rockets, etc. are seriously polluting the environment, and here we are particularly concerned with the possibility of depletion of stratospheric ozone which protects life on earth from the deadly ultraviolet radiations from the sun. For the sake of perfection science education must also convey to the students the humanistic values of science.

Members of the scientific community in several developed countries of the world have often in recent times expressed strongly against the utter abuse of scientific skill and have proposed proper action by the scientific societies and agencies in these countries to frame codes of conduct that their fellow members do not engage themselves in unethical practices even under political pressure. They have also many planned programmes to creat an awareness among the common man regarding the beneficial potentialities of science as also the harmful effects of chemicals which are the bye-products of many of the activities of modern man which pollute our environment and make it deleterious to life. In these countries scientific knowledge and skill has been applied successfully to develop control measures to minimise pollution.

The scientific societies of such developed countries also fulfil their social obligations in various ways such as advising the Government and the nation in curriculum development, research funding policies and programmes, etc. and also in assisting and advising its fellow members in professional matters and their proper placement in jobs where their knowledge and experties may be used fruitfully. For the dissemination of knowledge they organise quite frequently symposia, workshops, conferences, etc. at national and international levels, apart from publishing journals in which research findings are published after rigorous scrutiny to ensure credibility and quality of the publications. These societies effectively serve the cause of science, the scientific community and the nation. These societies are also responsible to ensure close interaction between science and technology in their countries, an interaction which is of mutual benefit to both science and technology and have a synergestic effect in the development of both science and technology. In contrast, the scientific societies, associations and organisations •in this country do very little indeed in this direction, excepting holding some annual get-togethers more as a ritual without any effective impact in scientific development in any real sense.

It goes without saying that the purpose of scientific research is advancement of the boundaries of knowledge and its aim is the establishment of truth. Hence, credibility and ethics are two most essential qualities of any one engaged in the pursuit of science. But, in recent times there has been a considerable erosion of our sense of values and credibility and ethics are sadly lacking among the members of our scientific community in general. In such a state of degenaration one can hardly expect any progress and development in any creative activity and science in particular. This is one of the reasons why despite our richness in scientific and technological manpower the impact of Indian science and technology in the national and international front has not been significant at all despite substantial investment by this poor nation in the R & D programmes since independence. Members of our scientific community are in an utter state of frustration, since honesty, integrity, competence, etc. which were once considered as virtues, are paying no dividend. Awards and recognitions can be earned by cheaper methods making these sheer mockeries.

Promotion of human welfare is one of the most tangible objectives of scientific endeavour. Late Jawaharlal Nehru had once said, "For a hungry man or a hungry woman, truth has little meaning... . we have to find for them all the absolute necessities of life". But despite this position it is essential to support science in all its aspects and in the fullest measure. Although the cultural and intellectual aspects of basic or fundamental research are not well appreciated by many this can hardly be undermined. But for basic research to flourish appropriate environment and adequate support are needed. Unfortunately there is a general tendency among the policy makers now-a-days to give much less priority to basic research. But it is basic research alone which widens the horizon of knowledge that makes a strong base for applied research and technology to flourish, since basic research helps to develop the human faculties to the highest degree that helps to solve a wide range of problems. But it is to be remembered that basic research has to be of the highest quality which encourages innovativeness and judged in this context what is now going on in most of our institutions can hardly be considered relevant to science in any form. Most of the papers published in Indian journals would corroborate this point.

As is true of any creative human enterprise, basic research can flourish only around a few really competent and talented individuals whose efforts must be supported as best as possible. However, the present day trend for so-called democratic management of institutions and research laboratories, where all are considered equal, is hardly conducive for the development of excellence in science. The academic freedom enjoyed by the members of the faculty of some Indian Universities in the pre-independent and also for some time in the post-independent periods was to a great extent helpful for academic excellence in these institutions. However, academic freedom cannot be equated with indiscipline. But in recent years under the banner of assumed equality and a sense of respect for fake democracy conditions have become far less conducive for development, promotion and cultivation of science, not to speak of excellent science. In this respect the situations are more or less the same in almost all the institutions in this country. The Government, both federal and state, has much responsibility in the matter as it frames rules and regulations for the administration of the universities and the institutions. In the name of democracy policy decision making bodies in most of the institutions and particularly the universities have been filled with men having very little interest, far less knowledge and expertise, for assessing the needs for academic development. From structural considerations the universities are best suited for basic research, but the universities which are supposed to be the temples of learning have now been totally crippled by undue political interventions, group rivalry, academic nepotism, unionism, etc. and are also grossly ill-equipped in terms of equipment and other facilities and quality of the teachers and hence lacking the infrastructure facilities for the cultivation and promotion of modern science. The future of science and technology certainly depends on the quality of manpower which the universities would provide. Hence, in our national interest we must make an all out effort to remove the maladies such that the universities are able to provide a strong ground for the cultivation and promotion of knowledge and are able to train up people to develop in them the awareness, capability and foresight to help the natton in its forward march to an all round success. However, no amount of reform at the university level only would bring the desired change, it is absolutely necessary to overhaul the system at the school and college levels also. In most of the schools and colleges the conditions are far from being satisfactory. Science eduction in the schools and colleges must be strengthened such that scientific temper may inculcate the young minds and they develop an interest and attitude to science. Science teaching in most schools and colleges is far from being satisfactory owing to a dearth of teachers of quality. This is partly because there is no scope to provide incentives to good teachers. In Japan, school teachers are encouraged in various ways to develop innovative teaching aids, demonstration experiments, etc. Demonstration of scientific principles through class room experiments is routinely followed in Japan and other developed countries. In pre-independent days this was a custom in many of the schools and colleges in our country, but this is no longer so to-day even in some of the so-called best schools and colleges. After independence, in our craze to spread education rather indiscriminately many schools, colleges and universities had been set up without taking into consideration the available material and human resources needed to run these institutions and this is largely responsible for the present state of affairs. The future of science will depend on our ability to attract the best quality of our young men to scientific pursuits and in this respect the various scientific and professional societies have an important role to play.

It is necessary to point out in no uncertain terms that higher education is not meant for the masses, and is meant only for the most deserving few. This can hardly be branded as elitist view because this aspect is well recognised both in socialist and non-socialist countries. But in our country flood gates have been opened for everybody to throng the universities and all this has been done with a false sense of vanity of spreading higher education. The undue haste in our attempt to impart higher education in regional languages also requires serious consideration as to its desirability and feasibility. It is indeed meaningless to talk about Japan and the Soviet Union in this case as the conditions there are very different.

Excellence in research can flourish around same gifted persons and small groups working under their dynamic leadership and for this we need an environment which is not the environment of the factories or of the Government offices. Both the different funding agencies and the administrators of the institutions should realise the need to support adequately the activities of such individuals and small groups. Their specific requirements of equipment and other facilities need most favourable consideration although these may not be the needs of the majority of the other faculty members whose interests may be quite different, or some of them may not have any interest at all as is also often true. But unfortunately most often, barring some exceptions, the funding agencies and the administration of the institution ignore such demands and only provide for all that is demanded by the majority or those having proper influence on them. By neglecting the legitimate demand of an individual or a small group doing research in a thriving area in science they destroy the energy and enthusiasm of the competent men having the ability to work in frontier areas of relevance. This hinders the advancement of science and the institution also loses an opportunity to gain fame as an excellent center of scientific activity. The visiting committees sent by funding agencies often do not have competent men with adequate knowledge and expertise for any objective assessment, nor do they have enough time to do the assigned job as best as possible and most often they are also guided by extraneous and petty personal considerations. Moreover, the universities in general do not have good facilities for the maintenance and upkeep of costly equipment which require regular attention and servicing. As a result whatever facilities are made available with the meagre resources remain inoperative most of the time. Apart from providing adequate infrastructural support to the competent individuals, it is also necessary to create an environment in our institutions which is not vitiated by any official red tape such that conditions are congenial for the activities to thrive and science to develop. Excellence often meets with a casualty in our institutions due to group rivalry, envy and jelousy of the less competent individuals and organised groups.

While the need to support basic research cannot be over emphasized, it is necessary to remember that basic research consumes wealth which in turn is generated by technology and this latter develops with the aid of science, and this is a cyclic process. While basic research should be a major activity in the universities for the training of students and for the advancement of knowledge, the training can become much more realistic and socially relevant and benefit both the students and the nation if the applications of knowledge are also kept in mind in the selection of research problems even in the universities, although each and every such problem need not be technology oriented. The existing Ph.D. programmes in the universities are far from being satisfactory as the investigations undertaken are mostly imitative, meaningless and even at times phoney and not all suited to create the inquisitiveness in the students or developing their faculties to the extent that they can become problem solvers and are able to face the challeges in the field. Our scientific societies, associations and organisations need to think seriously of this state and should organise seminars, symposia, workshops, etc. to discuss such issues critically so as to be able to evolve methods for an all round improvement of the science research programmes and also may help to identify areas of research as may be relevant to science and the society in the present time. ☐

D. Banerjea

HUNDRED YEARS OF HERTZIAN WAVES

B. R. NAG*

The Discovery

Electricity and magnetism has been known from the very early days of human civilization. Systematic studies of the phenomena were, however, made from the last part of the eighteenth century. Coulomb discovered in 1785, the law of interaction between two point electrostatic charges. In 1820, Oersted stumbled upon the fact that electric currents produce magnetic effects. The effect was quantified by Biot and Savart in 1824. Then in 1825, Faraday discovered electro-magnetic induction. Finally, in 1864, Maxwell integrated all these discoveries and introduced the doctrine which in his own words asserted 'that the true electric current, that on which the electromagnetic phenomena depend, is not the same thing as the current of conduction, but that the time variation of the electric displacement must be taken into account in estimating the total movement of electricity'. This doctrine led him to conclude that 'the condition of things at the point 0 at any instant depends on the condition of things at a distance Vt and at an interval of time t previously, so that any disturbance is propagated through the medium with the velocity V'. The velocity V was found by him to be equal to $v(=1/K\mu)$, K being the specific capacity and μ the permeability of the medium. Thus, by introducing the displacement current Maxwell showed that an oscillating current should produce electric and magnetic fields or electromagnetic field, which travels as a wave. He then proceeded to prove that light is also an electromagnetic wave. His conclusion was based on the argument, 'on the theory that light is an electromagnetic disturbance propagated in the same medium through which other electromagnetic actions are transmitted, V must be the velocity of light, a quantity the value of which has been estimated by several methods. On the other hand, v is the number of electrostatic units of electricity in one electromagnetic unit and the methods of determining this quantity have been described *else where.* They are quite independent of the methods of finding the velocity of light. Hence the agreement or disagreement of the values of V and v furnishes a test of the electromagnetic theory of light'. The values of v (calculated from the values of K and μ) and of V as measured at the time of Maxwell, were of the same order of magnitude, although not exactly equal, which fact was taken as a proof of the electromagnetic theory of light. Maxwell apparently was interested more in understanding light than in exploring the electromagnetic wave. The existence of the electromagnetic wave, the wave which he predicted would be generated by an oscillating current, was not pursued by him experimentally.

---

*Centre of Advanced Study in Radio Physics and Electronics, Calcutta University, Calcutta.

A few years later, in 1888, Hertz performed the required experiment, perhaps in response to Helmholtz's question set in 1879 for a prize of the Berlin Academy. The question was, "Whether the polarization and depolarization of an insulator should produce in its neighborhood the same electromagnetic effect as a galvanic current in a conductor'. Hertz attached two 40 cms square brass plates to two short rods terminating in brass knobs, which formed a spark gap. Sparks were produced in the gap by an induction coil connected to the knobs. An oscillatory current of a period of about 1.4×10^{-8}s passed in surges across the gap. To detect any possible electromagnetic wave, a zinc plate was placed at a distance, and the field in the space between the oscillator and the plate was explored by detectors in the form of wires bent into circles with ends terminating in knobs between which sparks were produced by the electromagnetic fields. By adjusting the distance between the knobs, the period of oscillations of the induced current in the detector loops was made equal to that of the source currents and Hertz detected variation of the response with distance and identified antinodal points as in acoustic stationary waves. The wavelength worked out to be about 4.2 m as would be expected if the electromagnetic field travelled with the velocity of light i.e. with a velocity of 3×10^{10} cm/s. The electromagnetic wave predicted by Maxwell became a reality through this experiment and Hertzian wave was born.

Physics of Hertzian Waves

Maxwell's electromagnetic theory of light was not readily accepted, as reduction of optics to a branch of electromagnetics was considered *bizarre.* Few scientists taught the theory, Helmholtz and Rowland being notable exceptions, who used it in their university lectures. However, the theory provided ready explanations for many phenomena in optics e.g., reflection, refraction, polarization, interference and diffraction, for the explanation of which the wave theory of light was propounded. It removed the difficulty of light being viewed as waves in a material medium, called the ether, which had to be ascribed unrealistic properties. Electromagnetic theory did not require postulation of ether, as the wave now meant wave like variation in the intensity of the fields.

In the first few years after Hertz reported his experiments, scientists did essential experiments to check the electromagnetic theory of light, to check if the Hertzian waves had all the properties of light wave. Although Maxwell's theory established that light and Hertzian wave were basically the same, there remained some distinctions. Light is produced by chemical reactions or by heating a material, has very small wavelength and can be sensed by human beings. On the other hand, Hertzian wave was produced by current oscillations, its wavelength could be made very large and it could not be directly sensed. Hence evidences other than the equality of the velocity of propagation were sought to firmly establish the equivalence of the two waves, generated in completely different ways. Experiments were conducted with Hertzian waves on reflection, refraction and polarisation. Reflection experiments were done using metals or slabs of paraffin and refraction experiments with prizms of pitch or paraffin. Gratings, which acted as Nicol's prism for these waves, were used to determine the planes of polarisation.

J. C. Bose made the most extensive contributions to establish the light-like properties of Hertzian waves. He made an important innovation. Hertz's waves had wavelengths of the order of meters and hence reflection and other experiments required objects of large size. It was difficult to eliminate the effects of stray signals, which arrived by diffraction and reflection from extraneous objects. Bose solved the problem by generating short Hertzian waves of 5 mm-1 cm wavelength and inventing the horn radiator, with which he could produce a radiation beam of 1 cm diameter. For detection, he used a coherer, the sensitivity and reliability of which was considerably improved by him. Bose constructed a portable apparatus to carry on investigations on the 'absorption of the Hertzian waves in various substances, the verification of the laws of reflection, determination of the refractive indices of several dielectrics, double refraction and polarisation in crystals, strain double refraction, anomalous conductivity associated with certain types of polarisers, rotation of the plane of polarisations by a bundle of jute fibres' and a few other experiments. He also invented detectors of Hertzian waves using selenium and galena crystals, which were the early forms of point contact detectors, used extensively at the time of the second world war, forty years later. In addition to carrying out experiments from the point of view of a physicist, Bose was one among the pioneers who saw the possibility of using the Hertzian waves for signalling to a distance. He successfully demonstrated this possibility by activating a pistol from a distance by using metal rods with discs at ends as radiating and receiving aerials. However, Bose did not pursue this possibility further. Such applications which have made Hertz's discovery, a vehicle for the evolution of the twentieth century civilization, were made by other scientists in the years that followed the first decade.

Wireless

Popov in Russia and Marconi in Italy experimented with Hertzian waves almost at the same time to send messages to distant places. Popov transmitted a message in 1896 to a distance of 250 m and then in 1897 he increased the distance to 5 km and finally in 1899 to 45 km. Marconi, on the other hand, announced in 1901 that he could send by using Hertzian waves, telegraphic messages across the Atlantic from Poldhu in Cornwall, England to St. John's, New foundland. Marconi's success in transmitting waves to distances beyond the line-of-sight round the curved earth established the Hertzian waves as a carrier of transatlantic telegraphic messages. Wireless was thus born and it was a boon to ships as dramatised by the Titanic disaster. The isolation of the ships at sea was now a thing of the past as they could be in constant contact with the shore and other ships by wireless. Invention of the wireless made Hertzian waves a useful gift of science to. mankind and captured the public imagination. A laboratory curiosity was transformed into a public untility.

Wireless continued to be the major application of Hertzian waves for the first two decades of the twentieth century till the first world war. The waves were very long in the 2000 to 20,000 meters range, were generated by sparks, arcs or alternators and detected by coherers and later by Fleming valves and De Forest audions.

Radio and Television

The invention of vacuum tubes (also called valves) changed the techniques of generation and detection of Hertzian waves. It became possible to generate high power waves in the wavelength range of 200-600 m and to modulate them with audio signals. Receivers were also developed which had great sensitivity. All these developments heralded Broadcasting and the first Broadcasting station started functioning in 1920 at KDKA, Pittsburgh. The age of radios began and Hertzian waves were now known as radio waves. Amateurs started using the waves all around the world to communicate with each other for pleasure. One such amateur, Godley found that transatlantic communication could be done better by using wavelengths below 200 meters. In course of time, the wavelengths of radio waves were made as short as 11 m or frequencies upto about 30 MHz were being used for Broadcasting. Radios encompassed the medium waves (200-600 m) as well as short waves (200-11 m).

The propagation of radio waves round the surface of the earth posed a new problem in physics. Attempts were made initially to explain the observation as being due to diffraction. But, quantitative agreement could not be obtained. In 1902, however, it was suggested that a conducting layer formed of ions produced by solar radiation in the upper regions of the earth's atmosphere may act as a reflector to cause the transmission beyond line-of-sight. The existence of such a layer was later deduced from the analysis of the peculiarities of short wave propagation and finally in 1926, proved by an echo-sounding experiment. The ionized region, so discovered, was named ionosphere and became a subject of intense study in later years. As short-wave radio communication in the form of telephony and broadcasting depended fully on the ionosphere, its properties were required to be understood. The physics of propagation of Hertzian waves through the ionosphere as affected by the earth's magnetic field was first clarified. The mechanisms of the formation of the ionosphere was then studied.

Ionosphere is a very complex reflector, having an extent from 60 km above the surface of the earth to the fringes of the earth's atmosphere. It is a variable medium, being controlled by the Sun. Hence, its characteristics had to be continuously measured and predicted for the satisfactory performance of short wave communication systems. Laboratories grew all around the world for this purpose. Significant contributions were made by S. K. Mitra and his students in this world wide activity. Interest in such studies has not died down as different problems crop up with the use of different parts of the spectrum of Hertzian waves for communication, and solution of these problems require a more complete understanding of the ionosphere.

In the same period, when Hertzian waves became useful for mankind as the carrier of telegraphic, telephonic and broadcasting signals, Television was invented to serve as an instrument of public entertainment. Television signals are also transmitted by using Hertzian waves. However, as the bandwidth for picture transmission is about 5 MHz, to transmit these signals, the technology had to be extended to meter range upto frequencies of a few hundred megahertz. Very high frequency (VHF) and ultra high frequency (UHF) techniques were developed for the purpose. The techniques were basically the same as for radio frequencies, but the sizes of the devices and transmission circuits were smaller. These high frequency waves are not reflected by the ionosphere. Transmitted signals on these waves reach the receivers directly. Only the intervening earth's atmosphere, the troposphere, affect the waves and these effects are of current interest in many parts of the world.

Radar and Microwaves

In the first half of the hundred years of Hertzian waves, public entertainment and communication were the main fields of its applications. Developments took a new turn at the beginning of the second half when World War II began. There was a resurgence of centimeter waves of Bose to meet the needs of the war. These waves were named microwaves and used in radars for the detection and ranging of distant objects. Radars were applied mainly to locate ships and aircrafts and also to map territories at the time of the war.

After the war, various forms of radars were developed to carry out different kinds of jobs. Ground-based radars are used for aircraft location, aircraft tracking, navigation, harbour and river surveillance, speed indication, weather monitoring, astronomy and ionosphere sounding. Radar on ships help searching for other ships, nearby land masses, buoys and in navigation. Aircrafts use radars for weather observation, navigation, collision avoidance, distance measurement, navigation, altitute measurement and mapping of territories. Radars are used by the military for tracking and detection of aircraft, missiles, ships, land vehicles, men, artillery and mortar shells and for different kinds of fire control, missile guidance, weapon fuses and reconnassance. To meet the multifarious requirements radars of many different kinds have been developed.

The operating frequencies of radars are in bands around 10, 16, 35 and 95 GHz and span the wavelengths from 3 centimeters to about 3 mm. These various kinds of radars have been developed in course of the last fifty years and the working wavelengths have been made shorter and shorter to reach mm's. Such developments continue to be the current activity with Hertzian waves.

Hertzian Waves in Space

The first artificial satellite the sputnik, was put in orbit in 1957. Satellites with different capabilities were developed in course of time. Some of them go round the earth, remote sensing territories to collect information about vegetation, minerals and military establishments. Others are used to collect data for weather forecasting, for transworld communication, for computer networking and other forms of data transmission. Using such systems, events are televised at homes from other ends of the world. Cloud formation, predicting the weather condition, are telecast for public convenience. The medium for all these services is Hertzian waves in the microwave (4-6, 11-14 GHz) range which travel to the satellites from ground stations or from satellites to reception centres. Satellites are monitored and guided also by microwaves.

The Hertzian waves have travelled deep into space along with the satellites exploring the solar systems. Such satellites transmit the collected information from Uranus and beyond by using Hertzian waves. However, Hertz's discovery and the subsequent technological developments also ushered in a new era of astronomy. Jansky made the serendipitous discovery that radio waves are emitted by our galaxy. This dicovery was followed up and a new window operating at millimeter to kilometer wavelengths was opened for the exploration of the Universe. New astronomical objects, Pulsars and Quassars, were discovered. The temperature of 3 K for the Universe was determined by measuring the residual microwave signals of the primordial radiation. Radio telescopes operate today to make observations of objects at distances of more than 10 billion years.

The Future

Hertzian waves are produced in nature by lightning and cosmic objects. However, as the waves can not be sensed by us like light or heat, their existence was not known before Hertz's discovery. In the hundred years following the discovery, the waves have been put to many different uses. Radio, Television, Radar, Satellites, Computer Networks, Communication systems, all use Hertzian waves as the carrier of information. The advent of semiconductor electronics has made possible miniaturisation of the transmitters and receivers. The waves are increasingly being applied using the miniature devices to serve various domestic purposes through cordless telephons, cordless buzzers, wireless toys, mobile radios, burglar alarms, automatic door closers, ovens and such other appliances. Applications go on multiplying every year. Many phenomena in physics are also studied by using Hertzian waves.

In the initial years of the application of Hertzian waves, the frequencies were low and wavelengths were long. The frequencies have gone up and the wavelength has been shortened over the years. Techniques of generation, transmission and detection of the waves have also been changing all the time. The gap between the Hertzian waves and heat rays i.e. the lower end of light waves has been narrowing every year. Shortest Hertzian waves now have wavelengths of fractions of a mm, merging with the heat rays. Coherence was a characteristic property of artificially produced Hertzian waves. After the invention of lasers, it has been possible to produce coherent light and heat rays. Consequently as Hertzian waves are displacing light in some applications e.g., in mapping and imaging, light is also being used in areas, such as communication systems and radars, in place of Hertzian waves.

The distinction in applications of the two forms of electromagnetic wave is gradually disappearing and one may expect that the merger of the two waves will be complete before the end of this century. The man-made electromagnetic wave will be one with the natural electromagnetic wave in all aspects of physics as well as of applications. ☐

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THE SUN AND THE SOLAR ENERGY

S. DEB*

1. Introduction

That the sun is the primary source of life and energy on the earth had been known from time immemorial. It is this realisation that had led to the cult of sun worship in ancient days. Instances also abound of man's early attempts at using sunlight in his own ingeneous ways. It appears that the art of making fire out of solar energy had been known long before the birth of Christ—records being there of holy virgins in the temple of Vesta in Rome lighting up the sacred alter fire using conical triangular concentrators in 700 B.C. 500 years after that, Archemedes used a mosaic type plain mirror solar concentrator to burn down the ships of the Roman invaders. Since then practicabilities of a variety of solar gadgets for use in domestic, agricultural and industrial fields had been successfully demonstrated. These form the topics of innumerable lectures, books, conferences, workshops and the like. A plunge into the vast stream of this literatures calls for a prior understanding of what the sun is, what sort of radiation it sends down to us, how this energy is distributed over the surface of the earth and in which broad ways this can be harnessed for use in day-to-day life. Brief answers to these questions constitute the theme of the present article.

2. The Sun

The sun is apparently the largest and the brightest heavenly body as seen from the earth. Actually, it is our nearest star belonging to a spiral galaxy at a distance of about 10 kilo par sec (1 kpc$=3.1 \times 10^{21}$ cm) from

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the central nucleus and is located at the inner edge of a spiral arm. It has the chemical composition and kinematical properties typical of other stars which together constitute the flat and the fast rotating (at 250 km/sec) disc of the galaxy. It is a so called G 2 type dwarf star.

(i) *The structure* : The sun is actually a gigantic and turbulent fireball of mass (M_o) 1.99×10^{30} kg and radius (R_o) 6.96×10^5 km with average mass density 1.410 ± 0.002 g cm^{-3}, mean surface temperature roughly 6000°K. Actually this last varies from about 6750°K at the centre to about 5500°K at the edge as seen from the earth. The sun is situated at a mean distance 215 R_o from the earth. It consists of a few distinct regions as described below :

(a) The central core of radius 0.23 R_o and mass 0.4 M_o at a temperature exceeding 1.5×10^7 °K and density exceeding 100 g cm^{-3}. It is here that the primary process, generating solar radiation, takes place.

(b) The core is followed by the photosphere which is the main source of radiation as received by us. Here, energy transfer takes place through convection, the density falls to 10^{-8} g cm^{-3} and temperature to 6000°K. About 35% of its surface is covered by unstable granules which have diametre 400-1000 km and are 35-40% brighter than the background. These are caused by convection. The centres of the adjacent ones are 2.5″-2.6″ apart with a mean life 8.6 ± 0.2 min. The photosphere emits continuous spectrum.

(c) Above the photosphere is a relatively thin reversing layer where the temperature drops to about 5300°C.

(d) The reversing layer is followed by the chromosphere—so called because of its red colour arising out of emission of H_α lines (6563 Å). It is composed of a large number of jets called spicula which intermingle at supersonic speed, causing excitation of shock waves. It is a transparent layer of rarefied gas, about 10^4 km thick and contributes about 10^{-3} of the total solar energy emitted. The temperature rises from about 4500°K at the base to 10^6 °K at the terminal layer. The density decreases outward. This is also the seat of selective absorption of the radiation coming from the inner region of the sun.

(e) The chromosphere is surrounded by the whitish glowing coronas consisting of highly rarefied and ionised gas at about 10^6 °K and extending to millions of km into the space. Its fractional contribution to emitted solar radiation is no more than 10^{-6}.

Apart from the above the sun also exhibits irregularities like the sunspots, the floculas and the flares. The sunspots have temperature of about 4500°K with a luminosity 18% of the normal areas and are probably of magnetohydrodynamic origin. Depending upon the size, the life of a sunspot varies from a few days to a few months. Floculas, found near the sunspot, are glowing white Ca cloud probably caused by microwave discharge. These are about 10% brighter than the background and have a mean lifetime of 30 min. Flares are chromospheric eruptions appearing and spreading at velocities upto 1000 km/s. They increase rapidly acquiring peak in a few minutes and declining within about 15 minutes and emitting intense UV, X-rays and corpuscular radiation.

The sun rotates about is axis more like a fluid body—equator rotating faster than the polar belts.

(ii) *Source of Solar Energy* : According to the most widely accepted theory, originally proposed by Bethe, the primary energy-liberating process in the sun is a thermonuclear one, caused in the core region by the high temperature and density. In the so called

$^{12}_{6}C^*$ process the following successive nuclear transformations occur** :

To start with there is a reaction with a proton ($^{1}_{1}H$) leading to the formation of the isotope $^{13}_{7}N$ and emission of γ radiation

$$^{12}_{6}C + ^{1}_{1}H \longrightarrow ^{13}_{7}N + \gamma, \qquad \cdots(1)$$

The introgen isotope then breaks into the carbon isotope $^{13}_{6}C$ and a positron

$$^{13}_{7}N \longrightarrow ^{13}_{6}C + \overset{+}{\beta}, \qquad \cdot\cdot(2)$$

$^{13}_{6}C$ then unites with a proton to form $^{14}_{7}N$ and emit γ-ray

$$^{13}_{6}C + ^{1}_{1}H \longrightarrow ^{14}_{7}N + \gamma. \qquad \cdot\cdot(3)$$

Union of the new nitrogen isotope with a second proton yields $^{15}_{8}O$ and more γ-rays

$$^{14}_{7}N + ^{1}_{1}H \longrightarrow ^{15}_{8}O + \gamma. \qquad \cdots(4)$$

The unstable isotope $^{15}_{8}O$ breaks into $^{15}_{7}N$ and positron

$$^{15}_{8}O \longrightarrow ^{15}_{7}N + \overset{+}{\beta}, \qquad \cdots(5)$$

The nitrogen isotope, finally, unites with a proton, as

$$^{15}_{7}N + ^{1}_{1}H \longrightarrow ^{4}_{2}He + ^{12}_{6}C \qquad \cdots(6)$$

At the end a helium nucleus is formed at the expense of 4 protons along with the original a $^{12}_{6}C$ atom to continue the chain. It may be shown that during the reactions (1)-(6) above a total mass 0.044 × 10^{-24} g is lost, and this is converted into energy following Einstein's law :

$$E = m\,C^2 \qquad \cdot(7)$$

A second possible process is the proton-proton reaction proposed by Bethe, Critchfield, Fowler and Lauritsch and described by the Equations** :

$$2\,^{1}_{1}H + 2\,^{1}_{1}H \longrightarrow 2\,^{2}_{1}D + 2\,\overset{+}{\beta} \qquad \cdot(8)$$

$$2\,^{2}_{1}D + 2\,^{1}_{1}H \longrightarrow 2\,^{3}_{2}He + \gamma \qquad \cdots(9)$$

$$^{3}_{2}He + ^{3}_{2}He \longrightarrow ^{4}_{2}He + 2\,^{1}_{1}H \qquad \cdots(10)$$

This would be possible if a contraction process, lasting about 5 × 10^{7} years, takes place.

These theories are supported by the presence of He in the sun to the extent of 2% of the total mass. This accumulation should be possible in 2 × 10^{9} years which is the lower limit of the sun's age deduced from meteors by the radioactive method. According to (7), 1 g of matter can produce 9 × 10^{20} ergs. The total luminous output of the sun is estimated to be 3.9 × 10^{33} ergs s^{-1}. Thus, over 4 million tons of solar mass must be annihilated per sec to support this output.

The radiation is produced in the core in the form of γ-rays and X-rays. These travel a distance of at least 0.7 R_0 from the centre before being converted into UV, visible and IR in the photosphere through secondary processes. Some of these radiations are absorbed in the cooler reversing and chromospheric layers giving rise to the dark Fraunhofer lines in the solar spectrum. The sun also emits corpscular radiation which is no more than about 10 particles cm^{-2} in the extreme outer region of the earth's atmosphere —the so called exosphere—and shielded from the earth's surface by the geomagnetic field.

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*Means a carbon atom of mass 12 AMV and atomic number 6

**Neutrinos have not been shown in (1)-(10)

3. Solar Irradiance : Outside the Atmosphere

The sun subtends an angle 31.54″ at the earth and of its total luminous output only that contained within the solid angle defined by this reaches the earth's atmospheric boundary. This is further weakened while traversing the terrestrial atmosphere, through absorption and scattering and is also qualitatively altered through selective absorption.

(i) *The Spectral Irradiance* : Neglecting the absorption lines, the spectral irradiance of the radiation, as received at the farthest boundary of the terrestrial atmosphere, is illustrated by curve B in Fig. 1 in which curve A depicts the same for a black body at 6000°K.

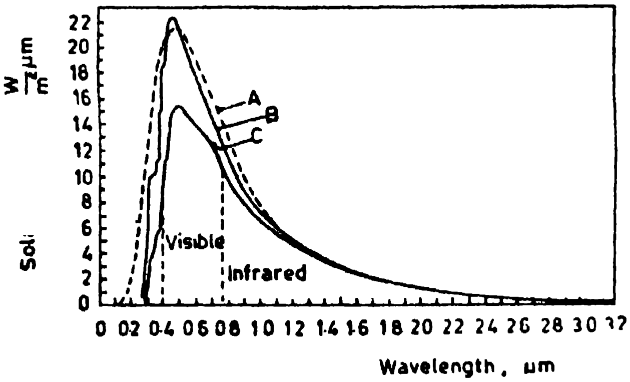

Fig. 1. Showing typical spectral distribution of solar radiation ; A : Energy curve for black body at 6000°K, B : Solar energy curve outside atmosphere. C : Solar energy curve at sea level.

Thekaekara has given accurate values of extra-terrestrial irradiance over 1 Å interval for the range 3000-6100Å.

(ii) *The Solar Constant* : Excepting the Solar Satellite Power Supply, which still remains a concept on paper, and space vehicles supplies all the solar gadgets have to be ground-based. As such the extra-terrestrial solar radiation would appear to be of secondary interest. However, a knowledge of the quality and quantity of this radiation is essential for estimation of the total energy emitted by and received from the sun. An useful concept for this purpose is that of the solar constant introduced by Pouillet in 1837 and determined by Langley in 1881.

The solar constant I_0 is defined as the quantity of solar energy incident on unit area placed normal to the solar ray path outside the earth's atmosphere at the mean sun-earth distance which is taken as the semimajor axis of the earth's orbit or 1.496×10^{11} m, also called the astronomical unit (AU). Usually this is expressed in Cal. cm^{-2} min^{-1}, (the langley) although the use of SI unit W m^{-2} should be more desirable. The NASA/ASTM standard value of the solar constant, accurate within ± 1.5%, is

$$\begin{aligned} I_0 &= 1.94\,\text{Cal cm}^{-2}\,\text{min}^{-1} \\ &= 1353\ \text{W m}^{-2} \\ &= 429.2\ \text{Btu ft}^{-2}\,\text{h}^{-1} \\ &= 125.7\ \text{W ft}^{-2} \\ &= 1.81\ \text{hp m}^{-2} \\ &= 1.94\ \text{Langley min}^{-1}. \end{aligned}$$

The solar constant I_0 gives the total solar irradiance for sun-earth distance equal to 1 AU. For any other distance the total irradiance is I_0 divided by the (distance in AU)^2*. There are reasons to believe that I_0 varies with the solar magnetic and the sunspots cycle. Speculations regarding the variability of solar constant, of course, exist. Rocket exploration and past data rule out more than ± 1% variation during the last 50 years. But it is thought that even a 0.1% variation can have marked effect on ecology and society.

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*Actually the sun-earth distance, on the n-th day of the year, is given by : sun-earth distance $= 1.496 \times 10^{11}$ $\left[1 + 0.017 \sin\left(2\pi \frac{n-93}{365}\right)\right]$ m.

(iii) ***Total Energy Received*** : The rate of receipt of the total energy from the sun by the earth'satmosphere has been estimated to be :

$$5200 \text{ Q Yr}^{-1} (1 \text{ Q} = 10^{18} \text{ Btu})$$
$$= 5.445 \times 10^{24} \text{ J Yr}^{-1}$$
$$= 1.5125 \times 10^{18} \text{ KWh Yr}^{-1}$$

Compared to this the total man-made energy in 1970 was only 2×10^{20} J !

4. Solar Irradiance at the Ground Level : Effect of the Atmosphere

The magnitude, spectral character and directivity of solar radiation are affected while it traverses the earth's atmosphere (curve C in Fig. 1). Under cloud-free condition, four distinct processes are responsible for this, viz ,

(i) Selective absorption by O_2, O_3, CO_2 and water vapour. This affects both the magnitude and spectral composition and also limits the shortwave radiation to 0.24 μ.

(ii) Rayleigh scattering due to molecular constituents of the atmosphere following the well-known λ^{-4}-law. Thus, short-wave dominates in the scattered light giving rise to the blue of the sky.

(iii) Mie scattering by aerosoles, viz., dusts, smokes and pollen's etc. having a size comparable to λ. A small amount of this light can also be absorbed by such particulate constituents of the atmosphere. This is a much more complicated and asymmetric process compared to (ii) and is prone to more pronounced statistical variations.

(iv) A small amount of radiation is also lost due to reflection at the top of the atmosphere.

With clouds, the following additional effects come into play :

(v) Absorption by water : With dense cloud this may approach 80-90%.

(vi) Scattering by molecular water in addition to (ii) and (iii) above.

(vii) Reflections at the top and the bottom layer of the cloud.

(a) *Airmass* : The effect of atmospheric absorption is conveniently gauged in terms of a parameter called the 'airmass' (AM). Its value, just outside the atmosphere, is taken to be zero (AMO). The noon-time absorption in summer, as oserved at the sea level, is assigned an airmass unity. At any other inclination the ray path traverses a greater mass of atmospheric matter and as such the AM increases above 1. If the ray path is inclined to the vertical at an angle i, (the solar zenith distance z), then conceiving of a mean molecular mass with a unique mass absorption coefficient for the radiation and disregarding the variation of g, the acceleration due to gravity with height, one can show easily that

$$\text{AM} = \sec i = 1/[\cos L \cos \delta \cos \left(\frac{2\pi t_h}{24}\right) + \sin L \sin \delta] \qquad \ldots(11)$$

which approaches infinity as $i \to \frac{\pi}{2}$. In this t_h = the time in hours (noon = 0), L = the latitute, δ = the declination of the sun with, $\sin \delta = \sin \left[E \cos \frac{2\pi t}{365} \right]$, E = the declination at summer solistice = 23°27 ; t = the time in days measured from June 21. A rule of thumb is that I, the irradiance for AMI is about 0.7 I_0, I_0 being the AMO irradiance. Hence, for AMK

$$I_k = I_0 (0.7)^k \qquad \ldots(12)$$

Actual data indicate a relation

$$I = I_0 \times 0.7^{(k)^{0.678}} \qquad \ldots(13)$$

and the spectral irradiance

$$I_k(\lambda) = I_0(\lambda) [I_1(\lambda)/I_0(\lambda)]^{(k)^{0.678}} \qquad \ldots(14)$$

(b) *Diffuse, Direct and Global Radiation*: Scattering, described under the heads (ii), (iii) and (vi) above, throws a part of the radiant energy off the normal course of propagation of solar radiation. The oncoming radiation, denuded of this, travels to the earth as a Direct Component. About 50% of the scattered component, relatively richer in shortwave radiation and devoid of a single specific directivity, also reaches the earth. This is called the Diffuse solar radiation. On a sunny day, the diffuse component accounts for roughly 10% of the total radiation. With increasing clouding its contribution tends towards nearly 100%, of the same. The meteorologist usually presents data on the two types of radiation in terms of incidence over a horizontal surface of unit area. Thus the defines :

The direct radiation I_H at a point as the total shortwave radiation passing through unit associated horizontal area from over a solid angle $\triangle_w$, subtended by the sun's disc at that point.

The diffuse radiation D at a point as the amount of shortwave radiation scattered by the atmosphere and reflected diffusively and transmitted by clouds that passes through unit horizontal area of the point per unit time. Here the related solid angle is $2\pi - \triangle w$.

The global solar radiation G is given by

$$G = D + I_H \qquad \cdot\cdot (15)$$

In case the unit area is held normal to the direct radiation the measured radiation is not I_H but $I_H/\sin h$, h being the angle of elevation of the sun.

(c) *Absorption and Longwave Radiation*: The radiation absorbed by the atmosphere and the earth are re-emitted as long infrared waves. A part of that due to the former travels towards the earth and that due from to the latter away the same. This part of radiation has the characteristics of black-body radiation at −60°−30°C. In view of the existing thermal equilibrium, the net shortwave energy absorbed by the earth/atmosphere system must equal the net longwave energy emitted. At any point, unit horizontal area receives a quantity of longwave radiation L_I from the surface and lets a quantity L_2 of such energy go per unit time, the net balance being L_1-L_2.

(d) *Reflection*: *Albedo*: A part of the incident global radiation is reflected back by the earth and is usually expressed as :

$$R = A\,G, \qquad \cdot\ (16)$$

where A is called the 'albedo' of the earth's surface. Its value depends on the nature of the soil, surface condition and angle of incidence.

The net radiation available is thus

$$Q = G\text{-}R + L_1\text{-}L_2 \qquad \cdot\cdot (17)$$

(e) *Turbidity*: This is determined by the vertically integrated amount of dust and other particulate matter in the atmosphere. Angstrom's relation, giving the transmission coefficient P_λ at λ is

$$P_\lambda = \exp\left(-\frac{\beta}{\lambda\epsilon}\right) \qquad \cdot (18)$$

when ϵ is a constant depending on the size distribution of particles and has an average value 1.3. β is called the Angstrom's turbidity coefficient.

(f) *The Total Daily Solar Radiation*: The total solar radiation H on a horizontal surface depends upon the hours of sunshine S. An expression relating the two was given in 1924 by Angstrom. Unfortunately, this involves the monthly average value of solar radiation on a horizontal surface per day for a clear sky which is not known precisely. Page, in 1964, gave a modified expression involving the average monthly insolation H_0 at the top of the atmosphere, viz.,

$$H = H_0 (A + B\, S/Z) \qquad \cdot\cdot (19)$$

Where A and B are constants and Z is the average hours of the length of the day per month and is given by

$$Z = \frac{\;}{15} \cos^{-1} (-\tan L \tan \delta) \qquad \cdots(20)$$

Duffie and Beckman gave $A = 0.30$ and B 0 34. Massion (1966), on the other hand, found empirically that

$$H = 60 + (1406.2\, S^2 + 7426.6\, S)^{\frac{1}{2}} \qquad \cdot\cdot (21)$$

H being in longleys day^{-1}. There are many other equations suggested by other authors on the strength of specific data.

Liu and Jordan (1960) have shown that

$$H_0 = \frac{24}{\pi} r\, B \left[\cos L \cos \delta \; \sin W + W \sin L \sin \delta \right] \qquad \cdot\cdot (22)$$

in which $B = 442$ Btu h^{-1} $ft^{-2} = 2$ ly min^{-1} $= 0.1396$ W cm^{-2}, r is the ratio of the intensity of normal solar radiation to the solar constant 0.1353 W cm^{-2} and varies from 0.9666 on the 21st July to 1.0335 on the 1st January and W is the sunset angle given by

$$W = \cos^{-1}(-\tan L \tan \delta) \qquad \cdot\cdot (23)$$

They also found that with dust-free cloudless localities, with minimum water vapour content in the atmosphere, the diffuse and the direct radiation varied with each other in a linear fashion—both being governed by the AM-value. According to them, under this condition, the total diffuse radiation H_D on a horizontal surface is given by

$$\frac{H_D}{H_0} = 0.3840 - 0.4160\, H/H_0 \qquad \cdots(24)$$

$$= 0.2710 - 2939\, H_t/H_0, \qquad \cdots(25)$$

H_t being the total direct radiation and $H_0 = 0.1396$ W cm^{-2}. For cloudy days Fig. 2 was claimed to give H_D to an accuracy of ± 5%. Other relations are available for the same purpose.

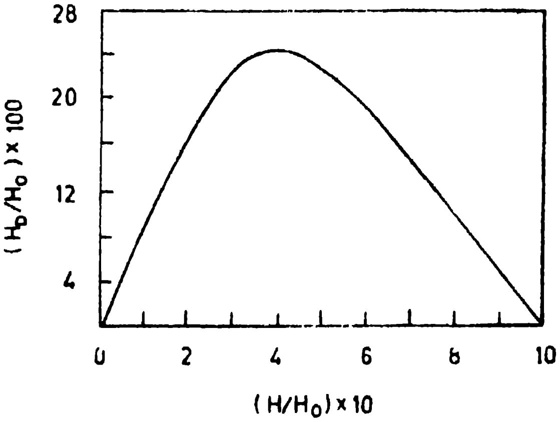

Fig. 2. Showing the relationship between the daily total solar radiation and daily diffuse solar radiation on a horizontal surface.

5. Data Acquisition : Typical Values for India

The solar energy received at a place has diurnal, annual and longterm variations that arise, apart from due to atmospheric effects, out of varying declination, sun-earth distance, length of the daytime and phase of solar activities. Measurement of solar radiation aims at accurate study and analysis of the pattern of these variations for the different components of radiation, as received on a horizontal and tilted surface at a place and to obtain reliable computational models, based on longterm data, in order to develop thereof practically feasible techniques of foreseeing the probable future values of these at the chosen place with reasonable degree of confidence. Such values constitute essential inputs to the optimum design of systems dedicated to harnessing solar energy for day-to-day use at the place. In spite of decades-old worldwide past studies the problem still remains an open one. With steadily increasing importance both from scientific and technological points of views.

A variety of instruments are used for recording solar data. A brief list of these is given in Appendix B along with procedures involved in presentation of the recorded data.

Reliable data on solar energy over India have been recently published by Mani and Rangarajan. They found that the mean monthly value of direct solar radiation, normal to the solar beam, at noon-time in India varies from 0.51-1.05 KW cm^{-2} depending upon the latitude, altitude of the station and season. During the whole year Rajasthan and Gujrat receives over 2000 KWh m^{-2} while Bihar, Bengal and Assam less than 1700 KWh m^{-2} out of global solar radiation. Marked decrease occurs throughout the country with the onset of the monsoon. The annual diffuse radiation increases from 740 KWh m^{-2} in Rajasthan, eastwards to 840 KW m^{-2} in Assam and south-wards to 920 KWh m^{-2} in the extreme south. In typical monsoon months of July and August exceeds 100 KWh m^{-2} over the Western part and is between 50-90 KWh m^{-2} over the rest of the country. The monthly average of the mean net longwave insolation is between 0.03-0.1 KWh m^{-2}. Albedo values are not available for many places. The recorded data indicates a mean value 0.30 with New Delhi value higher than those at Poona.

The turbidity values are higher over the Central and Northern India and for the country, as a whole, highest during the hot, dry premonsoon summer months and least during winter. Calcutta has an exceptionally high turbidity owing to local industrial pollution.

6. A Case for Harnessing Solar Energy : The Existing Snags

The Eastern India, excluding Orissa, comprises an area of about 6.25×10^{5} km^{2} while the rest of India 2.9×10^{6} km^{2}. With the annual average receipt of 1700 KWh m^{-2} for the former and 2000 KWh m^{-2} for the latter, as mentioned earlier, we find that India receives about 6.6×10^{15} KWh of solar energy each year. This is several 10^{4} times our current annual consumption of electricity. Thus, even a 1% of the received solar energy converted into useful form, at 10% conversion efficiency, can assure a few ten times our supply of energy. This possibility has encouraged a good deal of interest in harnessing solar energy in our country.

Three principal routes exist for harnessing solar energy. These are the Thermal, the Electrical and the Chemical methods of conversion. Sub-routes and their hybrid counterparts are given below :

Thermal	: Heating, Distillation, Drying, Cooling and Running Prime Movers, Furnaces and Wind Mills.
Electrical	: Photovoltaic and Photogalvanic Conversions.
Chemical	: Photosynthesis : Biomass.
Thermal/Electrical	: Ocean Thermal, Thermoelectrical and Thermionic Conversion.
Thermal/Chemical	: Thermochemical Conversion.
Electrical/Chemical	: Photoelectrochemical conversion and Photolysis.

Technical feasibilities of most of these various methods of conversion have been established beyond doubt. These ensure pollution free generation and supplies at the points of use. But much remains to be done in respect of economic viability and social acceptance. The process of photosynthesis had actually been evolved by Nature herself but is plagued by an extremely poor efficiency. This last drawback also applies to Photolysis, Photogalvanic, Thermionic and Thermoelectric methods. To that extent these require comparatively more efforts for attainment of practicability. A great handicap of solar energy is its intermittend nature, arising out of predictable and unpredictable variations. This makes a continuous and reliable supply system, based on this, a difficult proposition without some integral arrangement for storage. Biomass/Ocean Energy and to a lesser extent, some forms of photoelectrochemical cells, posses this feature. A few special applications like lifting water for irrigation, can also work without storage. But for others we have yet to search out satisfactory means of storage.

7. Importance of Data on Solar Energy

Irrespective of actual method of harnessing adopted, a satisfactory design of solar energy conversion system, requires reliable data on solar insolation at the point of use as stated in Sec. 5. Any design, based on average values, computed from recordings at unevently scattered handful of stations, carries the risk of serious future operational trouble. In spite of the aforesaid attempts by Mani and Rangarajan to chronicle the existing available data, the fact remains that these represent observations at only 25 stations which is quite meagre for a vast country like India. Facilities for recording of insolations must be more extensively distributed. Moreover, while the usual meteorological data relate to incidence on a horizontal surface, many solar devices require those for a tilted surface normal to the direct beam. Again, for some such applications it is the direct radiation that is of paramount importance, but for others both the direct and the diffuse radiation count. To that extent we need many more people familiar with the techniques of measurement of solar energy. □

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APPENDIX—A

Some Important Solar data

Mass (M_o) = 1.99×10^{30} Kg

Radius (R_o) = 6.96×10^{8} m

Average density = 1.410 ± 0.002 g cm^{-3}

Mean sun-earth distance = 1.496×10^{11} m = 215 R_o

Mean angular diameter as seen from earth = 31.54′

Total luminous output = 3.9×10^{26} Joules sec^{-1}
Total radiation reaching the outer atmosphere = 1.5×10^{18} KWhyr^{-1}
Total radiation reaching the earth's surface = 1.0×10^{18} KWhyr^{-1}
Mean surface temperature = 5750°K
Solar constant beyond the terrestrial atmosphere (AMO) = 1.94 Langley min^{-1} = 0.135 W cm^{-2}
Solar Constant at standard sea level (AMI) = 0.10 W cm^{-2}

APPENDIX—B

Measuring Instruments for Solar Energy

Instruments based on calorimetric heating, liquid evaporation, differential thermal expansion, photographic recording and thermoelectric, photovoltaic and photochemical conversion have been developed for measuring the various aspects of solar energy. Only the most frequently used ones of these are briefly described below.

The Eppley pyranometer/solarimeter is based on measurement of thermo—e.m.f. due to differential heating of a succesion of black and white wedge-shaped sectors arranged in a circular chain and protected by one or more glass domes. It measures the global irradiance (G). A shading ring is used to cut off direct radiation to measure the diffuse component (D). The ring may be moved slowly with time tracking the sun to record G and D vs time leading to the moving shadow version of the instrument. The pyranometer is a spectrally non-selective device with a field of view 2π and is the most widely used instrument in solarimetry.

As opposed to the above, the pyroleliometer has a field of view 6″ only and tracks the sun continuously to record the direct component (I) incident normally on a surface. Such data are useful for solar collectors using concentrators.

A simple handy instrument for measurement of G is the Robitzsch bimetallic recorder. The Central Electronics Ltd's. Suryamapi measures the same using a silicon solar cell. In the thermoelectric Albedometer a pair of pyranometers—one directed upwards and the other towards the earth—measures G and R to give the albedo. Filters may be coupled to a pyranometer to record I (λ).

The so-called sunshine recorders are intended to give the direction of sunshine above a chosen level—say 0.3-0.4 langley min^{-1}. In the Campbell-Stoke version a lens focusses the sunlight on a moving treated paper that is burnt when the focussed radiation exceeds a certain level. The length of the burnt track gives the duration of bright sunshine above that level.

From G vs t curve one gets

$$H = \int_{h_1}^{h_2} G \, dt,$$

as the total energy over a time h_1 to h_2. In practice approximate integration methods with the G-t curve broken down into a number of convenient segments (either linear or steps) is more convenient.

Day-to-day measurement of H logically leads to the pattern of monthly and yearly variation at a place. Analogous procedure is adopted to comput H_I and H_D and there long-term variations. ☐

Notes and news

Cutting water

Using water as its blade, a cutting device makes a star out of a 32-mm thick piece of metal-matrix composite during a routine demonstration at the Lockheed Aeronautical System Company in Marietta, Georgia, USA. Hailed as an abrasive water-jet, it utilises an exceedingly thin and high-power stream of water, mingled with garnet abrasives, to incise metal or composite material to fashion aircraft components.

Since the above device produces a narrow and smooth incision, materials are cut cleaner without any ragged edges. There are no deformation or thermal delamination problems. The process is reportedly four times faster than traditional cutting methods and dust is virtually non-existent. □

Span

Cholesterol free

There is good news for egg lovers. US scientists have "developed" eggs that do not raise levels of cholesterol—a villain in heart attacks and strokes. As a matter of fact, such eggs reduce blood pressure and triglycerides—compounds contributing to heart disease. An egg of the regular kind averages 274 mg of cholesterol. As recommended by the American Heart Association, people should not consume more than 300 mg of cholesterol per day, the high levels of cholesterol in blood are linked to increased risk of hardening of the arteries and consequently to heart attacks.

Suk Y. Oh and his colleagues at the University of Utah "created" these eggs by adding fish oil to chicken feed. Fed on this diet for 8 weeks, hens laid eggs lowering blood pressure and blood fats in a batch of 12 healthy people. However, there is a demerit. These eggs had the smell and taste of fish. But, states Oh, this is a minor problem which can possibly be solved by feeding hens deodorised fish oil.

Oh's subjects were divided into two groups, each person having 4 eggs daily for 8 weeks. The first group ate fish-oil enriched eggs for the initial period of 4 weeks, which appreciably decreased their blood pressure without altering their blood cholesterol. When they switched over to regular eggs for the last 4 weeks, their cholesterol levels enhanced by 5-10% and their blood pressure was restored to their original value and their triglyceride levels shot up significantly.

The results of the second group, which began first on a regimen of ordinary eggs and later transferred to the "fishy" eggs, were diametrically opposite. At the end of 4 weeks, their blood cholesterol levels registered a sharp increase. By the end of the 8th week, their cholesterol levels had dropped to normal and their blood pressure and triglyceride levels also declined appreciably.

Once the preliminary findings are confirmed in a large-scale investigation, which Oh expects to be soon, people can eat as many of these eggs they desire sans the risk of developing coronary heart disease. Fishy eggs could then join low-cholesterol egg substitutes in America by 1989. However, they will be approximately 40% expensive than regular eggs because of the added price of fish oil. □

Span

Deep-sea mining

India has formulated a time-bound action programme to undertake deep-sea mining by the early part of the 21st Century. Under the programme, the country would take steps to acquire the know-how for mining of polymetallic nodules at depths of 4,500-6,000 m and develop the technology to extract metals from the nodules. Scientists at the Department of Ocean Development (DOD), New Delhi, believe that mining of nodules would be technologically possible, economically feasible and ecologically acceptable.

S. Z. Qasim, Secretary, DOD stated, "India will soon start an intensive survey of the mining site, alloted to the country by the International Sea-bed Authority in the Central Indian Ocean, for large-scale mining of nodules along with environmental studies". A broad time-frame for the development and commissioning of the commercial plant which was expected to mine about three million tons of dry nodules per annum, has been evolved. The pilot plant for nodule processing would be commissioned in 1990, semi-commercial plant by 1995 and commercial plant by 2005.

According to S K. Mukherjee, a Senior Officer of DOD, there are three methods—hydraulic-lift system, continuous line-bucket mining system and modular or shuttle-mining system—used to mine nodules from the deep sea. During the test mining, the nodules would be harvested in one cruise and stored there. However, during commercial mining, separate bulk carriers would be deployed as transport vessels to maximise the utilisation of the mining vessel with high degree of endurance. The transfer of nodules to transport ships could be achieved by two alternate modes—slurry transfer and conveyor or pneumatic transfer. Shore terminals would be required during the commercial mining stage for unloading and storage of nodules and to provide necessary logistic support to the mining operation. Such a port could be set up in Cochin or Paradip.

Based on the results of pilot plants, the optimum route would be selected. For this process, a semi-commercial plant having a rated capacity of 170 tons a day would be installed. Finally, a commercial process plant with a yearly capacity of 300,000 tonnes would be set up. The purpose of whole exercise is to reduce the country's dependence on imports of cobalt, copper and nickel. ☐

The Statesman

Weather forecasting in computer, a thing of the future

A ten-day forecast using numerical wheather prediction models on a supercomputer like the Cray X-MP is still a thing of the future, according to Prof. P. K. Das, former Director General of the India Meteorological Department (IMD) and currently Professor Emeritus at the Indian Institute of Technology, Delhi.

Striking a note of caution he said : "By stating that such a prediction would be possible we are at the danger of presenting an over-optimistic picture of the extent of possible immediate use of the supercomputer. It is a very difficult proposition at least in the initial stages. A realistic forecast beyond 48-72 hrs ahead should not be expected".

Prof. Das was participating in discussion among Indian and American experts in the field over the U.S. Worldnet Service. The other participants were Dr. R. P. Sarkar, D. G., IMD, Prof. M. P. Singh, Head, Centre for Atmospheric Sciences. IIT-D, from India and Dr. Roy Jenne of the National Centre for Atmospheric Research (NCAR), Boulder, Colarado, and Prof. T. N. Krishnamurthy, Head, Centre for Meteorological Research, Florida State University, from the American side. This television dialogue was arranged by the Science Office of the US Embassy in New Delhi.

Error and noise : According to Prof. Das the problems arose due to ill-understood nature of the optical properties of clouds thus causing error and noise in the data inputs to a dynamical weather forecasting modelling exercise. He asked how does one filter noise from data in such a situation. He also stressed the importance of the model taking into account the dynamics of the ocean-atmosphere coupling, the role of the reversal of fast moving ocean currents off the Somali coast and chilling of the Arabian Sea during the monsoon.

While Prof. Krishnamurthy agreed on the importance of the points raised by Prof. Das, he said that tackling of such problems was still in experimental stages and added : "We have to decide on where do we start and when we have a supercomputer".

"Operational forecasting, however, is another bag", he said, "if you have data sets you have to process it within a few hours. We should, therefore, pay good attention to data inputs". Comparisor of data sets which are inputs at various forecasting centres around the world should be made, he felt. Commenting on the specific problem raised by Prof. Singh relating to sparse data over the Indian Ocean region and the Himalayas, Prof. Krishnamurthy said that the Indian satellite INSAT should be fully exploited for such data as well as for cloud drift wind data at least two levels in the vertical.

The need to evolve dynamical models, rather than statistical and regression models of the kind used this year to make monsoon predictions was emphasised by Dr. Sarkar. "We know that statistical models work when there is a reasonable expectation of normal rainfall", he said in a lighter vein. There was a general praise from the American experts on the successful Indian exercise of statistical forecast of rainfall this year. According to Dr. Sarkar of the 35 meteorological subdivisions in the country, 33 had reported above normal rainfall and in the rest the deficiency from the normal had been marginal.

Quality control : There was general agreement among the experts on the need for quality control of data. Dr. Jenne said that errors that arose in data inputs were essentially of two kinds : Instrumental error, arising due to tracking by detectors, and sampling error. For example, the 'rawind' data sample is bound to neglect thunderstorm winds of that were of much more local nature than the resolution adopted in the model, he said. But talking about the state-of the art in modelling techniques he said that the European Centre for Medium Range Weather Forecasting (ECMWF), using a Cray X-MP/48, was now able to provide 6-7 day forecast of overall atmospheric flow pattern at 170 km resolution of data points with 86 per cent accuracy. Very short range, 1-2 days ahead, with very high resolution should be possible with the kind of system that India is acquiring Dr. Jenne said. He further remarked that if the right kind of data is available outlook forecast for medium range should be possible.

In response to the question raised by Prof. Singh on the comparison of Cray X-MP/14 with other machines in use at other centres. Prof. Krishnamurthy said that with the model T106 currently in use at the ECMWF it takes about one hour to carry out forecast for 24 hours ahead. This should be possible with the single processor Cray X-MP/14, he said, which according to him is a fast machine with reasonable memory. "Our experience", he said, "is that most researchers still use only one processor and only at the ECMRWF full operational use of all the four processors of the machine is being made". Dr. Jenne supplemented the observations by stating that Cray X-MP/14, using a T42 model with 300 km resolution of data input, is able to achieve 83 million floating operations per second performance for a 10 day simulation of weather patterns.

Expected by mid-October : The Indian supercomputer is expected to arrive by mid October, according to Mr. Ahmed Meer, former Science Counseller at the US Embassy, though the company Cray Inc. was ready to ship the system in September itself. The readying of the building at the IMD, New Delhi, that will house the system and its air-conditioning, etc. are being awaited. ☐

The Hindu

14 scientists bag INSA awards

Fourteen scientists, all below the age of 33, (5.10.88) today received the Indian National Science Academy (INSA) young scientists awards for 1988.

The awardees included three researchers—Dr. Rahul Pandit, Dr. A. G. Samuelson and Dr. Y. N. Srikant—from the Indian Institute of Science, Bangalore, and two agriculture scientists, Dr. V. K. Arora and Dr. Zora Singh, from the Punjab Agricultural University, Ludhiana.

The other award winners were Dr. M. M. Chaturvedi and Dr. Eklabya Sharma from the Banaras Hindu University, Dr. S. K. Mahata from the Calcutta University. Dr. C. M. Nautiyal from the Birbal Sahni Institute of Paleobotany, Lucknow. Dr. M. Durga Prasad from the University of Hyderabad. Dr. A. Jayaraman and Dr. Utpal Sarkar from the Physical Research Laboratory, Ahmedabad. Dr. Sandhya Visweswariah from the Astra Research Centre, Bangalore and Dr. K. Majumdar, scientist with the International Centre for Genetic Engineering and Biotechnology, New Delhi. ☐

The Hindu

Acid rain poses global threats

The scientific community recently requested EPA administrator to list acid aerosols normally as "criteria pollutants" and to set standards for acid aerosols to protect public health. Preliminary studies indicated that exposure to acid aerosols at concentrations above ambient levels impairs ability of respiratory tracts of humans and animals and that bronchitis among children has correlation with hydrogen ion concentrations. The Scientific Community demanded acid rain legislation under the "Clean Air Act". Besides acid deposition poses a serious ecological problem. If left unchecked, it is apprehended that the problem of rain water acidity will multiply manifold.

Called acid rain, rain water acidity now poses a growing threat. It does not even spare rain—the elixir of life. The natural sources of water is no more clean.

The primary sources of acidity of rain are man's over pre-occupation with the industrialisation requring fossil fuels as the primary inputs for the industries. Their combustions emit excess of sulphur dioxide and oxides of nitrogen mainly into air. Being acidic oxides, these are converted into sulphuric acid and nitric acid respectively by reaction with water.

The important sources for these acidic oxides include power houses, automobiles, domestic fires, smelters etc. A major portion of sulphur dioxide and oxides of nitrogen comes from coal and petroleum fuels during their combustion.

Acidity of rain water is usually measured by its pH. If it is 7, it is said to be neutral. If it is less than 7, rain water is acidic and in case, it is higher than 7, the solution is alkaline. Normally, clean rain is slightly acidic. This is due to the presence of dissolved carbon dioxide in varying amounts in it. As a matter of fact, pH of clean rain water is 5.6. But for acid rain, pH is generally much lower than that. pH values of rainfalls over much of eastern North America vary from 4 to 4.6.

The effect of acid rain is not confined to the local region alone. It may be dispersed to a greater distance from the initial sources. The long-range dispersion of the pollutants takes place presumably due to modern techniques recently introduced in the industries for throwing away the pollutants further with the hope of cleansing the local air. The impact is much deeper. And so it needs precaution.

Although rain water acidity at Bangalore, Delhi, Hyderabad and Nagpur remained constant more or less. Pune shows a trend towards higher acidity. Bombay and areas like Trombay show quite acidity (pH being 4.45 and 4.85 respectively) in 1974.

Rain water acidity in India has yet not reached an alarming level. It may be due to the fact that India's atmosphere is loaded high with dust capable of neutralising acids. Because acidification of lakes does not take place at lower than 4.6, a long time will be required to over-come the natural buffering action provided by the alkalinity of the dissolved calcicum salts in water. The problem in India, therefore, has not assumed a too serious position. Except for some buildings and the stone monuments near the close vicinity of polluting sources, the effect in India is not as serious as the outside world.

Taj Mahal in Agra is showing signs of pitting. This is probably due to acidic fumes from the nearby Mathura Oil Refinery.

As a matter of fact, power-generation industries contribute largely to the pollution of the environment by sulphur dioxide. Indian coal has a fairly low sulphur content of about one per cent. This is another advantage for which acid rain in India has yet not assumed a very threating position.

Effects of rain acidity are numerous. Forest damages are likely. Acidity kills aquatic flora and fauna. Acidity kills fish, green algae and many bacteria. In West Germany, damage to the forests is extremely high.

Acid rain is the biggest cause of friction between Canada and the United States for long years. Canada's Prime Minister, Brian Mulroney left Washington after completing his two days' official visit without winning agreement he had hoped from President Reagan to protect his country from impacts of acid rain which severely affects grain production and aquatic life. It is revealed that thousands of lakes in Canada and the USA have become so acidic that these have been rendered unproductive. Across Canada and northern US, the entire tracts of lakes and streams are devoid of aquatic life.

The phenomenon of acid rain has a great devastating effect upon vegetation, soil and surface water. It is revealed that about 70 per cent of acid rain falling on eastern Canada comes from burning of fossil fuels in the United States. But a year ago, both Mulroney and Reagan agreed to reduce emissions. Reagan now says he still wants "further study".

According to Mulroney, Canada has lost fish in 15000 lakes and that life of 300,0'0 more is threatend. Although Canada acted to reduce its own sources of acid rain for lowering sulphur dioxide emissions in eastern Canada to half of 1980 levels by 1994, it estimated that the cost in reduction of sulphur dioxide as well as nitrated would be prohibitive amounting to about 6,200 million dollar a year. In this perspective, Canada now thinks to invest on new clean coal technologies rather in reduction of emissions of sulphur dioxide since many of the current plants will be due to replacement soon.

The US government has spent about some 600 million dollar sincs 1980 for studying the problem. But only 4 states—Kessachusetts, Wisconsin, Minnesota and New York have applied emission control acts for sulphur dioxide.

Environmental Defence Fund's (EDF) study in New York showed that nitrogen oxides dropped from the sky either in rain, snow or in dry form outweigh oxides from sewage and factories (23 per cent) and ammonia from manure (18 per cent). These in turn form sources of nitrate in Chesapeake Bay, the largest estuary in the US. Fertilizers contributing about 34 per cent of nitrates have also shown greater impacts on eastern coastal waters.

Several reports indicated that nitrogen oxides from the US power plants, factories and automobiles have caused destruction of fish and other creatures in the Atlantic bays and estuaries. Trucks and cars contributed about 36 per cent of the nitrogen oxide in the US atmosphere in 1984. Electrical power plants also contributed about 32 per cent.

Nitrogen oxides encourage rapid growth of algae in salt waters. The overload of nitrogen causes marine algae to bloom. This blocks sunlight and depletes oxygen supply. This was so in the coastal waters of New York and North Carolina. In this way, the coastal ecosystems are becoming dangerously polluted. It is believed that only the tighter Federal restriction on nitrogen oxide emission can be a feasible proposition on the solution of the problem for the time being.

It is estimated that about 25 per cent of the nitrogen which contaminates Chesapeake Bay is the result of acid rain. Although there is no dispute about pollution problem of the bay, the US Environmental Protection Agency (EPA) claims that contribution of nitrogen oxides is much lower than 25 per cent and that the agricultural run off and the dumpings of industrial sewage are far worse contributions.

There can be some remedies, use of low-sulphur coal is one. Natural gas may be favoured. Dependence on hydel power is one other Nuclear power also can be of great help if the escalation of rain water acidity is to be arrested.

Again, there may be two ways to remove the obnoxious gas. The first method consists in filtering emissions through lime filters. The second method consists in burning a mixture of coal and lime.

In the wake of serious threats arisen out of acid rain, every nation must frame a policy to control emissions of the acidic oxides. ☐

P. C. Bhattacharyya

CSIR Director-General gets extension

Dr. A. P. Mitra, Director-General of the Council of Scientific and Industrial Research (CSIR), whose term is to expire in February 1989, has been granted extension for two more years by the Prime Minister's Secretariat. The extension orders were issued on November 22, 1988. Dr. Mitra who became the Director-General of CSIR, on February 26, 1986, was earlier the Director of the National Physical Laboratory (NPL), New Delhi. He is also a Fellow of the Royal Society (FRS) of London.

Speculation as to who would succeed Dr. Mitra, has been laid to rest with this decision. According to some observers, this may be due to the Prime Minister's keenness to see that the recommendations of the Abid Husain CSIR Review Committee are fully implemented under the present DG itself in whose time the recommendations were passed by the CSIR Society and implementation of some already intiated. The Committee's recommendation on the appointment of Directors of the CSIR institutions and the DG, CSIR, is one non-renewable term for a period of six years. The Prime Minister is the president of the CSIR Society.

Dr. Mitra has been closely associated with the scientific programmes under the CSIR in the implementation of various technology missions, particularly the water and oil seeds mission, and projects that are being implemented in the mission mode. The continuance of Dr. Mitra as the DG is also being seen as a reflection of the need to maintain the tempo of the implementation of those aspects of the missions which he is supposed to be familiar with. ☐

The Hindu

Letters to the editor

Transport of water across various forms of clays

Reports of studies on thermal diffusion of water in soil are available[1-3]. Recently, the phenomena of thermal diffusion and, in particular, thermoosmosis in soil/clay systems have also been closely examined[4-7]. However, the qualitative aspects of non isothermal transport processes in clay systems were left largely unemphasised. The present communication is an extension of studies of non-isothermal transport processes to those across different clay samples in various cationic forms. Special emphasis has been laid upon the evaluation of heat of transport of water, a non-equilibrium thermodynamic parameter, which is strongly dependent on the nature of interactions inherent in the system, and is thus expected to be related to the specific surface charge density of the clay samples used[4,5].

The clay samples were isolated from Sajnekhali saline soil, Sundarban, West Bengal and Jhargram laterite soil, Midnapore, West Bengal by following the standard sedimentation technique[8]. The resulting clay samples were then turned to Na-form by repeated leaching with 2M NaCl and dialysed. The calcium and magnesium forms of the clays were prepared by treating the Na-form with 2M solutions of $CaCl_2$ and $MgCl_2$ respectively. The specific surface area values were determined by the method due to Dyal and Hendricks[9]. The diffusion cell, as well as the experimental methodology followed for studying thermal diffusion of water, was the same as suggested by Bhattacharjya and Sanyal[10]. The experiments were performed at four different temperature gradients for each clay sample. In the non-isothermal diffusion cell, the central clay chamber was sandwiched between the terminal water chambers, and a horizontal temperature gradient was imposed across each clay water boundary. The temperature drop across the clay water boundary was measured by the standard potentiometric technique under steady state conditions.

For thermal diffusion of water, the heat of transport ($\hat{Q}_w$) was obtained from eq. 1[11].

$$\hat{Q}_w = \bar{V}_w T_m(\Delta P/\Delta T)_{st} \quad (1)$$

where $\bar{V}_w$ is the molar volume of water and T_m, the mean (absolute) temperature, $(\Delta P/\Delta T)_{st}$ refers to the steady state pressure difference across the clay chamber. $\hat{Q}_w$ may be defined as the amount of heat absorbed per mole of a diffusing water from the region it leaves and released in the region it moves into under isothermal conditions[4,11].

The heat capacity of transport ($\hat{C}_w$) of water in the given system was calculated by substituting the appropriate slope of the plot of $\hat{Q}_w$ *vs* T in eq. 2, namely,

$$C_w = \frac{d\hat{Q}_w}{dT} \quad (2)$$

Experimental results were recorded in tables 1 and 2. The standard deviations in $\hat{Q}_w$ are given in the parenthesis below each $\hat{Q}_w$ for various forms of soil clays. The positive values of heat of transport of water ($\hat{Q}_w$) correspond to an absorption of heat behind the diffusing water and a liberation ahead in course of diffusional migration through the central chamber[4], and may be explained in terms of structural order present in the bulk water, *vis a vis* that in the sorbed water in the central clay chamber[6,7,10].

TABLE 1 : Heat of transport of water across various forms of Sajnekhali clays

Sample	Specific Surface area/ $m^2.g^{-1}$	Mean temperature/°A (Tm)	$\bar{V}_w$/ml. mol^{-1}	Temperature difference/°C (ΔT)	10^2 $(-\Delta P/\Delta T)$/ atm. deg^{-1}	$\hat{Q}_w$/J. mol^{-1}	$10^2 \times \hat{C}_w$ at 39°C/ J. mol^{-1}. deg^{-1}
		309.8	18.07	4.2	1.78	1.01 (± 0.026)	
		310.9	18.06	6.0	1.96	1.12 (± 0.020)	
Sajnekhali Na-clay	243.46	312.3	18.06	7.8	2.19	1.25 (± 0.020)	9.61
		313.4	18.08	10.3	2.35	1.35 (± 0.023)	
		310.0	18.07	4.1	1.88	1.07 (± 0.036)	
Sajnekhali Ca-clay	230.41	311.1	18.08	6.2	2.05	1.17 (± 0.010)	
		312.2	18.07	8.4	2.24	1.28 (± 0.011)	9.60
		313.2	18.08	10.2	2.38	1.37 (± 0.017)	
		310.1	18.07	4.1	1.98	1.12 (± 0.010)	
Sajnekhali Mg-clay	183.95	311.4	18.06	6.2	2.17	1.24 (± 0.015)	
		312.4	18.07	8.3	2.32	1.33 (± 0.010)	9.59
		313.3	18.08	10.2	2.49	1.43 (± 0.020)	

TABLE 2 : Heat of transport of water across various forms of Jhargram clays

Sample	Specific Surface area/ $m^2.g^{-1}$	Mean temperature/°A (Tm)	$\bar{V}_w$/ml. mol^{-1}	Temperature difference/°C (ΔT)	$10^3(-\Delta P/\Delta T)$/ atm. deg^{-1}	$\hat{Q}_w$/J. mol^{-1}	$10^2 \times \ddot{C}_w$ at 39°C/ J. mol^{-1}. deg^{-1}
		310.1	18.06	4.3	1.50	0.85 (± 0 034)	
Jhargram Na-clay	98.74	311.3	18.07	6.3	1.67	0.95 (± 0.015)	
		312.3	18.07	8.5	1.82	1.04 (± 0 020)	9.68
		313.4	18.08	10.6	1.97	1.13 (± 0.011)	
		310.0	18.07	4.3	1 64	0.93 (± 0.015)	
Jhargram Ca clay	87.18	311.3	18.06	6.3	1.84	1.05 (± 0.015)	
		312.4	18.07	8.4	2.07	1.16 (± 0.026)	9.64
		313.4	18.07	10 4	2.20	1.27 (± 0.015)	
		310.1	18.07	4.3	1.72	0.98 (± 0.010)	
Jhargram Mg-clay	75.86	311.2	18.06	6.3	1.95	1.11 (± 0.011)	
		312.3	18.07	8.4	2.17	1.24 (± 0.010)	9.62
		313.4	18.08	10.4	2.37	1.36 (± 0.010)	

The larger $\hat{Q}_w$ values for Sajnekhali clays than those for the Jhargram clays evidently arise from a more extensive ordering sphere of influence of Sajnekhali clays[10] having higher specific surface area. The value of $\hat{Q}_w$ of both Sajnekhali and Jhargram clays in the magnesium form is higher than that of the calcium and sodium forms. This may be owing to the higher ionic potential of magnesium ion which leads to a greater loss of "local" entropy of water in the clay chamber"[10]. An increase in mean temperature will enhance the kinetic energy of the water molecules in bulk, especially in relation to that of sorbed water in contact with the clay particles. This should augment the positive magnitude of $\hat{Q}_w$ at higher temperatures, and hence a positive $\hat{C}_w$ (vide, Tables 1 and 2).

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Influence of Various herbicides on the seed production of *Cassia sophera* var. *purpurea*

The use of herbicides in controlling weeds and their impact on the growth and metabolism of crop plants have been well-documented[1]. However, very little or no attention has been directed towards the formation of propagules—bulbs, rhizomes, seeds, tubers, etc.—in treated plants which undoubtedly serve as a means of dissemination and infestation of weeds in newer regions. The severity of any weed species in the forthcoming season will depend on the development and survival of viable propagules[2]. Thus, the choice of herbicides for adversely affecting the growth performance and reproductive activity of a weed is of paramount importance. The aims of this investigation are to ascertain the influence of ten different herbicides on the seed output, seed weight and seed viability of *Cassia sophrea* L. var. *purpurea* Bak. This species is common in non-arable lands, thriving along roadsides and in waste places in the proximity of Calcutta. The speed with which it is occupying wider tracts has attracted interest to eradicate this plant for agricultural or industrial purposes[3].

Seeds (scarified by 20-min conc H_2SO_4 treatment and followed by thorough washing in water) of *C. sophera* var. *purpurea* were sown in earthen pots of 25-cm diam and 22-cm height. After a sufficient number of seedlings emerged, they were thinned down to 10 per pot. When the plants were 30 days old, they were aerially sprayed by means of a hand-held pressurised sprayer with various concentrations (0.01, 0.1, 1.0 10, 100 and 500 ppm) of ten different herbicides. The herbicides were MCPA (4-chloro-2-methyl-phenoxyacetic acid), 2, 4-D (2, 4-dichlorophenoxyacetic acid), 2, 4, 5-T 2, 4, 5-trichloro-phenoxy acetic acid), 2, 4, 5-TP [2-(2, 4, 5-trichlorophenoxy)-propionic acid], 2, 4-DB [2, 4-dichlorophenoxy)-butyric acid], MCA (monochloroacetic acid), DCA (dichloroacetic acid , TCA (trichloroacetic acid), Dalapon (2, 2-dichloropropionic acid) and MH (maleic hydrazide or 1, 2-dihydro-3, 6-pyridazinedione). Aqueous solutions of these herbicides were made and pH of the solutions adjusted to 7.0. Spraying was done once in the case of phenoxys, while the same was repeated thrice for aliphatics and MH. Following the sprays, fruits and seeds produced from treated plants were collected. Fruits and seeds were also harvested from plants (control) free from any herbicidal treatments. Seed output was determined and 100-seed weight measured (by the use of a single-pan electrical balance)[4]. The viability of seeds (after chemical scarification with conc H_2SO_4) was expressed as percentage germination. While there were ten replicates for seed output, there were four replicates each for seed weight and seed viability (with 25 seeds per replicate). The results are expressed as ± S.E. (standard error).

Except MCPA, where all concentrations augmented seed output and seed weight, the same responses were brought about by 0.1 ppm of the remaining phenoxy herbicides (Table 1). In the latter, these two parameters declined progressively with increasing concentrations from 10 ppm onward. Among the non-phenoxys, both parameters increased with increasing concentrations of three herbicides (MCA, DCA and TCA) and decreased correspondingly in two herbicides (Dalapon and MH). Whereas the greatest reduction in seed output was induced by 500 ppm 2, 4, 5-T in the phenoxy series and 500 ppm MH in the non-phenoxy one, the corresponding values for seed weight were recorded with 500 ppm 2, 4-DB and 500 ppm Dalapon. Following sprays with MCA and DCA, seed viability increased progressively with increasing concentrations. However, TCA yielded erratic results. In the rest of the herbicides, there was a lowering of seed viability with increasing concentrations. In fact, seed viability decreased maximally with 500 ppm 2, 4, 5-T and 2, 4-DB among the phenoxys as well as 500 ppm Dalapon and MH among the non-phenoxys.

The present study confirms the findings of Kasera and Sen[5] that post-emergence application of herbicides adversely affects the growth performance of treated plants and the subsequent formation of seeds. In their work, they tested one level each of Agrodone (Concentrate 48, Agrodone 18% W.P. and Agrodar 96 on three weeds ; the first two herbicides contain ethyl ester of 2, 4-D and the last dimethyl amine of 2, 4-D. Since these are commercial formulations, the quantum of active ingredient in each herbicide is not stated. Moreover, they are silent about the mode of application—whether the herbicides were applied as foliar spray or as soil dressing. Nevertheless, we agree with their conclusions : "The reduction in viability and seed output of weeds due to herbicidal treatment can be used as a main tool for prediction of weed infestation in the forthcoming season." In this respect, 2, 4, 5-T, 2, 3-DB, Dalapon and MH serve as promising herbicides, all at a concentration of 500 ppm.

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TABLE 1 : Effect of ten herbicides on the output, weight and viability of seeds of *C. sophera var. purpurea*

Concentration of herbicides (ppm)		Seed output/ plant	100-seed weight (mg)	Percentage of seed viability
Control (water only)		212 ± 23	1363 ± 69	80 ± 1
MCPA	0.01	350 ± 37	1211 ± 54	80 ± 0
	0.1	369 ± 38	1427 ± 45	78 ± 3
	1.0	388 ± 41	1456 ± 37	75 ± 0
	10	410 ± 57	1451 ± 81	75 ± 2
	100	576 ± 78	1495 ± 83	70 ± 0
	500	771 ± 84	1611 ± 100	62 ± 0
2, 4-D	0.01	259 ± 27	1324 ± 71	78 ± 7
	0.1	573 ± 65	1629 ± 100	72 ± 5
	1.0	268 ± 21	1571 ± 84	72 ± 0
	10	237 ± 16	1502 ± 76	70 ± 3
	100	214 ± 11	1446 ± 39	67 ± 1
	500	203 ± 8	1409 ± 41	63 ± 0
2, 4, 5-T	0.01	167 ± 6	1014 ± 35	75 ± 8
	0.1	499 ± 67	1570 ± 81	70 ± 6
	1.0	226 ± 29	1485 ± 72	69 ± 1
	10	210 ± 15	1434 ± 32	68 ± 4
	100	195 ± 7	1216 ± 51	65 ± 2
	500	111 ± 4	1150 ± 43	60 ± 0
2,4,5-TP	0.01	158 ± 6	1306 ± 63	80 ± 9
	0.1	226 ± 21	1602 ± 98	75 ± 7
	1.0	215 ± 15	1547 ± 74	70 ± 0
	10	196 ± 12	1532 ± 92	67 ± 5
	100	187 ± 10	1416 ± 74	64 ± 3
	500	173 ± 11	1348 ± 67	60 ± 1
2,4-DB	0.01	193 ± 8	1054 ± 36	78 ± 7
	0.1	302 ± 25	1286 ± 54	75 ± 2
	1.0	263 ± 27	1270 ± 49	72 ± 0
	10	258 ± 22	1255 ± 58	70 ± 3
	100	215 ± 14	1165 ± 65	65 ± 2
	500	209 ± 7	1082 ± 82	60 ± 1

TABLE 1 (Contd.)

Concentration of herbicides (ppm)		Seed output/ plant	100-seed weight (mg)	Percentage of seed viability
MCA	0.01	163 ± 8	1299 ± 61	70 ± 0
	0.1	172 ± 6	1413 ± 41	72 ± 1
	1.0	184 ± 4	1428 ± 38	75 ± 6
	10	219 ± 18	1438 ± 47	80 ± 7
	100	234 ± 26	1447 ± 64	85 ± 8
	500	291 ± 15	1462 ± 59	87 ± 5
DCA	0.01	163 ± 13	1358 ± 38	70 ± 0
	0.1	171 ± 17	1442 ± 67	72 ± 2
	1.0	192 ± 12	1458 ± 53	75 ± 3
	10	205 ± 15	1483 ± 63	78 ± 4
	100	209 ± 29	1493 ± 73	80 ± 6
	500	231 ± 14	1505 ± 45	85 ± 5
TCA	0.01	145 ± 15	1292 ± 65	73 ± 9
	0.1	163 ± 18	1382 ± 56	78 ± 4
	1.0	172 ± 16	1424 ± 51	77 ± 4
	10	211 ± 12	1463 ± 73	80 ± 8
	100	224 ± 18	1493 ± 83	80 ± 9
	500	227 ± 17	1512 ± 92	80 ± 7
Dalapon	0.01	445 ± 54	1515 ± 97	85 ± 6
	0.1	297 ± 27	1432 ± 90	80 ± 6
	1.0	235 ± 23	1382 ± 87	75 ± 6
	10	219 ± 12	1371 ± 73	72 ± 2
	100	184 ± 15	1113 ± 63	64 ± 3
	500	166 ± 12	1058 ± 39	62 ± 4
MH	0.01	187 ± 17	1698 ± 42	87 ± 6
	0.1	166 ± 16	1426 ± 54	80 ± 4
	1.0	147 ± 9	1406 ± 73	75 ± 5
	10	143 ± 8	1342 ± 60	70 ± 6
	100	138 ± 7	1322 ± 80	65 ± 1
	500	107 ± 6	1152 ± 90	60 ± 0

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Preliminary studies on the effect of location and variety on the quality characters of soybean

It was earlier reported that location influenced the protein content of pulses[1]. However, others[2,3] obtained inconsistent results on the effect of location. The present investigation was therefore undertaken to study the effect of location and variety on the quantity of protein, ether extract and limiting amino acids (methionine and tryptophan) in soybean.

Six promising varieties of soybean (*Glycine max*. L.) were grown under identical conditions at Delhi, Amravati and Junagarh. Composite samples from three replicates at each location were collected and analysed for their crude protein, ether extract, methionine and tryptophan contents by the methods described earlier[4].

It has been found that these six varieties of soybean varied in their crude protein content from 36.3 to 45.8 per cent (Table 1) indicating differences among them. 'Yellow soybean' variety grown at Amravati contained the maximum amount of protein (47.8 per cent). 'Lee' and 'Hampton' varieties showed some differences in their amount of protein at two places. 'Lee' variety contained 37.7 and 44.0 per cent protein at Delhi and Junagarh, respectively. 'Hampton' variety contained 36.3 and 43.0 per cent protein at Delhi and Amravati, respectively.

These varieties differed in their content of ether extract from 17.0 to 25.1 per cent indicating that variety and location seem to influence this constituent. Only varietal differences were statiscally significant. It has been found that protein and ether extract constituents are negatively correlated (– 0.217) indicating an inverse relationship between them, but it is not significant. Those varieties which are high in their protein content are low in their ether extract and vice versa, as could be seen in case of 'Yellow soybean' and 'Hampton' varieties.

The amount of methionine and tryptophan in these varieties differed from 1.06 to 1.49 per cent and from 0.76 to 1.27 per cent in the protein, respectively. Methionine in protein showed statistically significant differences by location. 'Clark-63' variety seems to contain slightly higher amount of tryptophan (1.12-1.22) per cent in the protein) at the three locations in comparison to others except 'Bragg' one which contained 1.27 per cent in the protein at Junagarh.

TABLE 1 : Quality characters of soybean grown at different locations

Variety	On moisture free basis		On moisture and fat free basis			
	Crude protein %	Ether extract %	Methionine % in seed	Methionine % in protein	Tryptophan % in seed	Tryptophan % in protein
Delhi						
1. Punjab-I	45.0	19.6	0.52	1.15	0.46	1.02
2. Clark-63	42.6	22.5	0.50	1.17	0.48	1.12
3. Hampton	36.3	25.1	0.48	1.32	0.36	0.99
4. Bragg	43.8	19.5	0.50	1.14	0.42	0.95
5. Improved pelican	45.1	20.1	0.48	1.06	0.46	1.02
6. Lee	37.7	24.1	0.52	1.38	0.33	0.87
Amravati						
1. Punjab-I	45.1	19.5	0.48	1.06	0.46	0.80
2, Clark-63	42.6	23.2	0.49	1.15	0.52	1.22
3. Hampton	43.0	24.0	0.50	1.16	0.33	0.76
4, Bragg	43.2	22.5	0.48	1.11	0.35	0.81
5. Improved pelican	45.8	20.6	0.51	1.11	0.36	0.78
6. Lee	40.6	22.6	0.57	1.40	0.31	0.76
7. Yellow Soybean	47.8	17.0	0.52	1.08	0.43	0.90
Junagarh						
1. Punjab-I	45.0	20.0	0.52	1.15	0.40	0.90
2. Clark-63	41.0	24.1	0.63	1.46	0.48	1.14
3. Hampton	39.6	23.2	0.59	1.49	0.34	0.85
4. Bragg	40.8	22.7	0.57	1.39	0.52	1.27
5. Improved pelican	41.8	21.4	0.55	1.31	0.44	1.05
6. Lee	44.0	22.5	0.57	1.30	0.41	0.93

TABLE 1 (Contd.)

Variety	On moisture free basis		On moisture and fat free basis			
	Crude protein %	Ether extract %	% in seed	% in protein	% in seed	% in protein
			Methionine		Tryptophan	
Statistical Analysis (a)						
Location						
'F' test	NS	NS	NS	Sig*	NS	NS
SEm	1.11	0.78	0.08	0.05	0.06	0.05
CD 5%	3.35	2.34	0.23	0.15	0.17	0.16
Variety						
'F' test	NS	Sig**	NS	NS	NS	NS
SEm	1.27	0.58	0.12	0 08	0.08	0.004
CD 5%	3.92	1.79	0.37	0.23	0.26	0.01

(a) Yellow soybean variety not included for statistical analysis.
NS Not significant
* Significant at 5%
** Significant at 1%.

The present study indicates that location and variety seem to influence the contents of ether extract and methionine in soybean, whereas variety alone has a tendency to affect the protein content.

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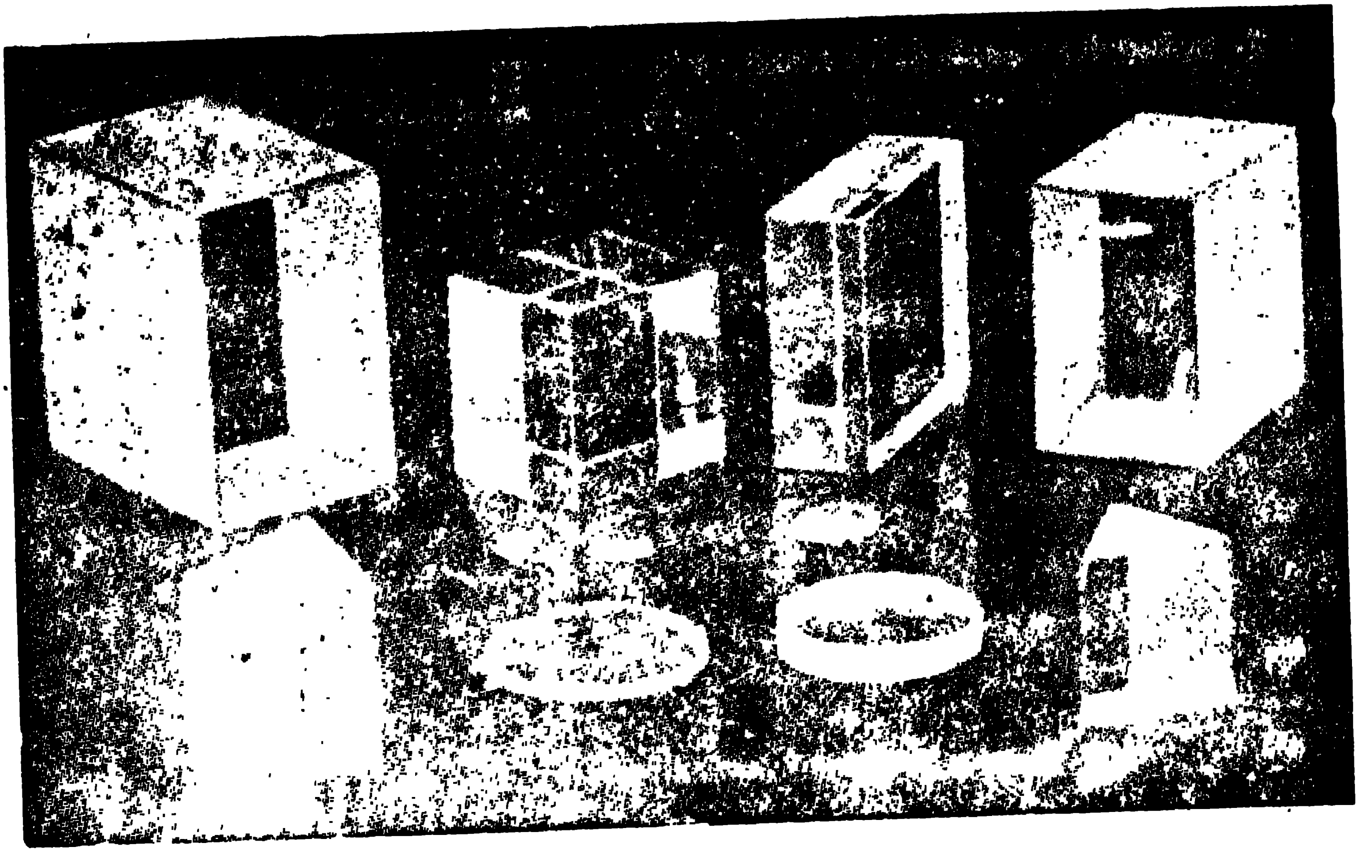

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